

INFLUENCE OF SUCTION PRESSURE
ON THE CAPACITY OF A SIX - CYLINDER
PACKARD ENGINE

BY

F. G. COOBAN

R. C. PALMER

E. STEPANEK

ARMOUR INSTITUTE OF TECHNOLOGY

1915

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Influence of suction
pressure on the capacity

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INFLUENCE OF SUCTION PRESSURE ON THE CAPACITY AND ECONOMY OF A SIX-CYLINDER PACKARD ENGINE

A THESIS

PRESENTED BY

FRANK G. COOBAN
ROGER C. PALMER
EMIL STEPANEK

TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

FOR THE DEGREE OF

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

HAVING COMPLETED THE PRESCRIBED COURSE OF STUDY IN

MECHANICAL ENGINEERING

MAY 27, 1915

J. F. Gebhardt 5/29/15

J. M. Raymond
L. C. Morin

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Proceedings of the American
Society of Automobile Engineers.
Erikson-Gumpper Thesis of 1904.

To Mrs. Julia B. Beveridge, Librarian,
we are especially grateful, not only for her

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1. The first step is to identify the problem or question that needs to be answered.

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efforts in the compilation of such data as appeared in the various technical journals, but also for many suggestions on the form of this thesis.

Roger C. Palmer.
Emil Stepanek.
Frank G. Cooban.

Chicago, Illinois.

The first part of the report is a general
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 The second part is a description of the
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 The third part is a description of the
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- The third part is a description of the results of the study.

The fourth part is a description of the conclusions of the study.

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Acknowledgments.

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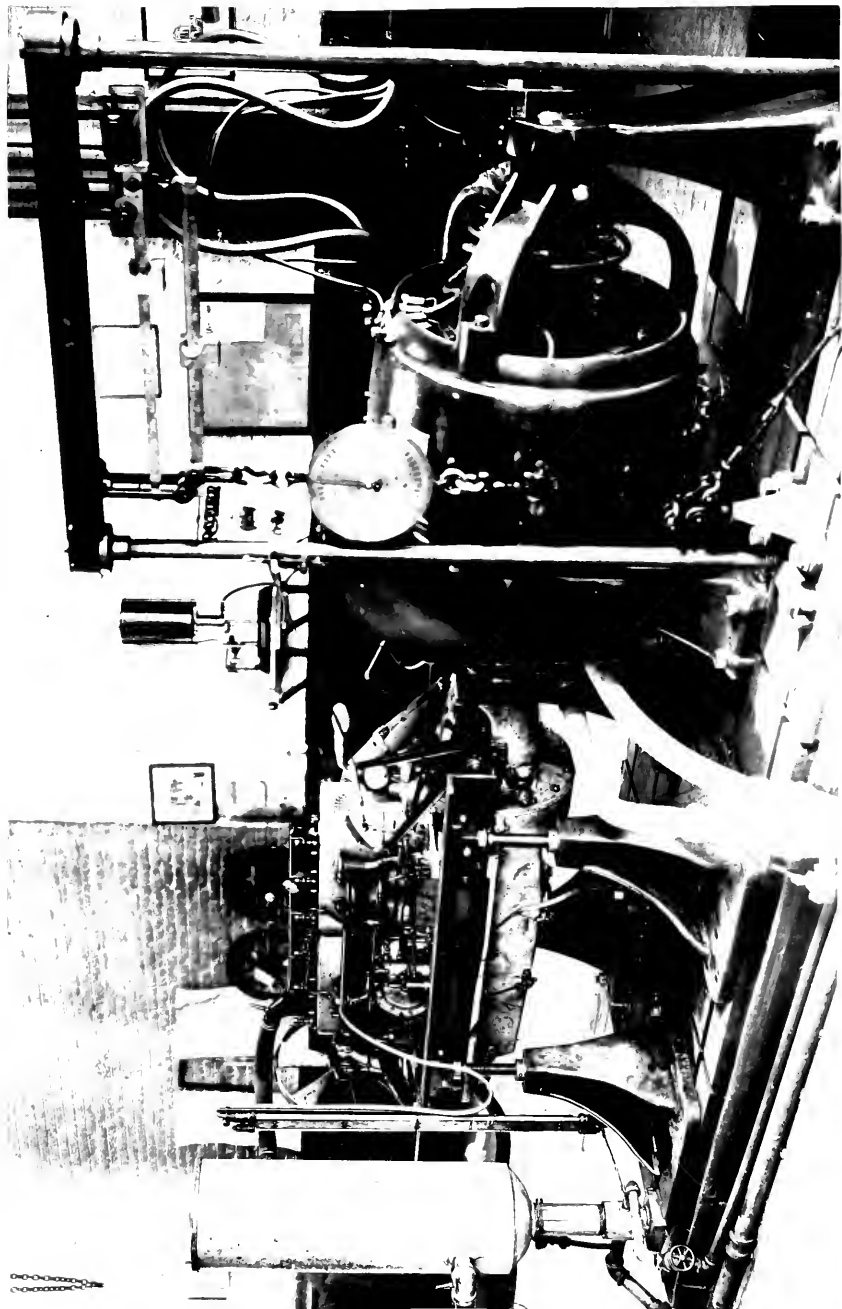
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PART I.

A Short Treatise on the Packard 38
Motor and a Description of the
Apparatus used in testing it.

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INTRODUCTION.

The object of this test is to determine the effect on the economy and power of a Packard "38" Motor by varying the suction pressure. Since the advent of the dynamometer in automobile motor testing, it has been found advisable in order that testing conditions may be uniform, to have all motors tested with full advanced spark and wide open throttle. This has caused some discussion as to effect of having the throttle in different positions, and has led to the investigation mentioned in the first sentence.

The Packard "38" Motor.

The Packard "38" is a six cylinder four cycle L-head motor, the cylinders having a 4 inch bore and 5-1/2 inch stroke, thus giving a bore stroke ratio of 1.375, and a horse power ratio S. A. E. of 38; the cubic displacement in each cylinder is 69.115 cubic inches, and the clearance volume 21.77 cubic inches. The cylinders are cast in blocks of three.

The valves are all on the right side of the motor, the exhaust head also connecting on this side. The inlet manifold is carried on the left side, and is split into three sections, each passing between two of the pairs of cylinders, one through the water jacket to the right side. The manifold connections, which are four in number, bolt to the left side of the cylinder casting and from these connecting points the mixture is distributed to the intake ports.

The inlet manifold has a straight horizontal main section, from which the cylinder

connections pass and a short section at right angles connecting with the carbureter. The manifold is water jacketed along its horizontal length; this together with added heating that the fuel receives in passing through the water jacket spaces in the cylinder, helps the efficiency of the motor considerably.

The exhaust manifold is of the double type known as the Siamese arrangement, in that each block of the three cylinders has a separate passage; that for the rear block is cast integrally with the front header, however, there is a connection between the two as far back as the flange where the exhaust pipe joins.

The lubrication is by a force feed from a gear driven pump located in the crank case. After being strained the oil is forced by the pump through an external pipe up to another strainer mounted at the forward end of the motor. It then flows down to the camshaft through an internal passage within that part of the forward end of the crank case which forms the rear of the timing gear housing.

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Holes drilled in the bearings communicate with the hollow center of the camshaft and as the latter revolves these register with the main lead just mentioned; this applies to the other bearings as well. Leads in the crank case web carry oil down to the crank shaft bearing and then through leads it is brought down to the connecting rod bearings. The connecting rods are also drilled and from here the oil is led to the piston pin bearings through the rods.

The carbureter is of the firm's own design, and manufacture, combining float feed, automatic mixture regulation for all motor speeds and uniform temperature. It has a water jacketed cylindrical mixing chamber, the auxiliary air inlet being automatically regulated for varying speed by a spring controlled poppet valve, the latter being controlled by a small lever which regulates the spring tension for varying atmospheric conditions. In connection with this carbureter is a hydraulic governor, consisting of a diaphragm enclosed in a compartment. The pressure of the water

system bears on one side of the diaphragm while the other side of the diaphragm is interconnected with the carbureter throttle, so that when the water pressure is greatest, due to a higher engine speed, the diaphragm is bulged outward and through a rod connection partly closes the throttle, thereby tending to maintain a uniform motor speed. The motor is cooled by positive water circulation through cellular motor cylinder water jackets by a gear driven centrifugal pump; together with a belt driven ball bearing fan.

Ignition, which is entirely independent of the lighting and cranking, is provided by a Bosch duplex system, using a single set of spark plugs. The high tension Bosch duplex magneto sends the secondary current directly to the spark plugs.

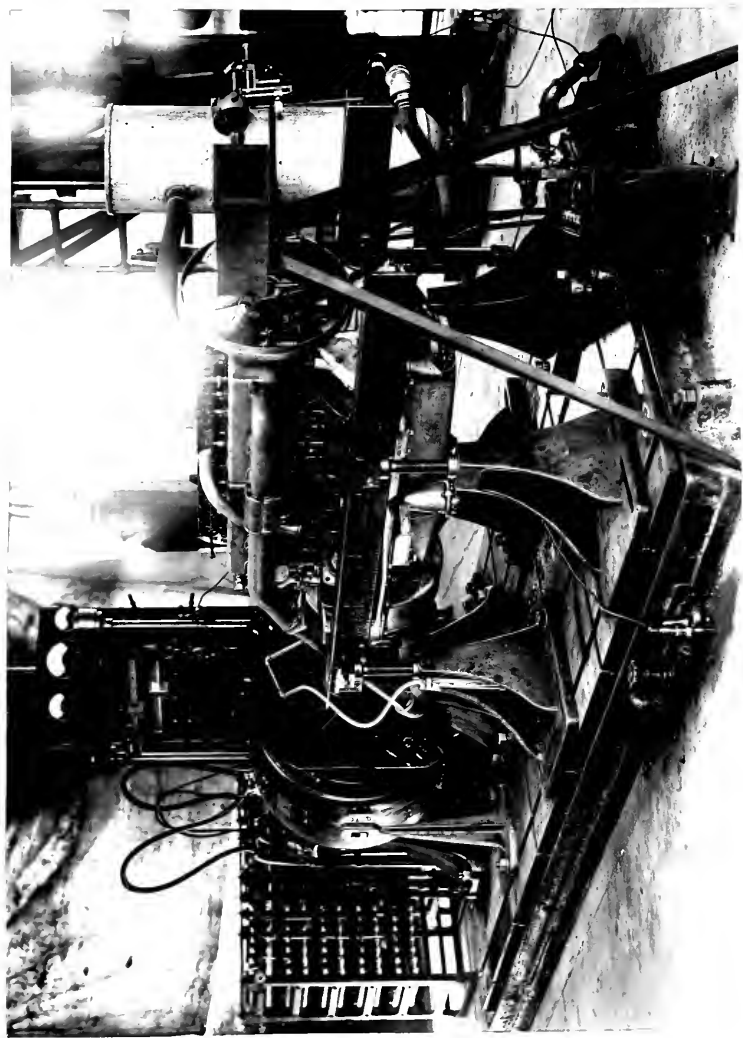


Fig. 2

Description and Operation of the Various Testing Equipment.

The Sprague electro-dynamometer was used in the testing of the Packard motor. Briefly, it consists of a one-hundred horsepower direct current inter-pole generator mounted on a cast iron bed plate. The torque is taken from knife edges screwed to the frame of the generator and transmitted through a drawbar and spring balance scales to a set of chatillion scales. The length of this arm is equal to 1.315 feet, so that the torque multiplied by the R. P. M. divided by 4000 gives the horse power developed. Ways are cast in the bed plate for holding down motor stands; these stands can be adjusted so as to accomodate any size motor and have the engine lined up with the armature shaft in such a way that a flexible coupling can be inserted between the two. The switchboard is mounted on pipe stands within reach of the scale beam. It contains the control switches, field rheostat circuit breaker, ammeter and voltmeter, for the electro-tachometer. In order to maintain a

steady field flux that will not vary with the speed, the field is separately excited. The drawing at the back of this thesis shows the electrical connections of the apparatus.

The following instructions for operating were sent out with the machine by the Sprague Electric Works.

Instructions for
Operating The Sprague
Electro-Dynamometer
"Preliminary Adjustment."

"The dynamometer should first be balanced at a standstill and before connecting it to the engine to be tested. Care should be taken that the incoming leads to the dynamometer frame do not exert a pull which interferes with the pull of the dynamometer frame on the beam scale. When a balance has been obtained with the beam scale reading zero, connect the engine to be tested."

Starting.

"Leave all the single pole switches open. See that the field rheostat is turned as far as it will go to the full field position. Close the field switch and be sure that there

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is a current in the field circuit. Trip the circuit breaker and put both interlocking switches to the right. Close the single pole switches in the upper row one at a time. The machine should start after two or three switches have been closed."

Operation as Motor.

"If it is desired to increase the speed in order to take a friction test at higher speeds than that of starting, continue closing the switches in the top row one at a time. When all of the top switches are in, close the circuit breaker which in turn short circuits the resistances. If speed is to be still further increased, open all the single pole switches and slowly turn the field rheostat handle so as to weaken the field.

PRECAUTION. Do not weaken the field before the circuit breaker has been closed and all single pole switches open."

Operating as Generator.

"Before operating the dynamometer as a generator, see that the field rheostat is

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turned to the full field position and two or three switches in the top row closed. When the engine to be tested has begun to run under its own power, throw the lower transfer switch to the left. The load is now increased by closing the switches in the top row and at the same time supplying more power to the motor being tested. Variation in speed is obtained by the field rheostat."

"To load the dynamometer at speeds below one half of normal speed as stamped on the dynamometer name plate, close three or four switches in the lower row, leaving the switches in the top row closed, and throw the upper half of the transfer switch to the left. The load may now be increased by closing the switches in the lower row one at a time."

"Care should be taken to manipulate the load switches and field rheostat so that the current does not exceed three hundred amperes and the voltage on high speed load does not exceed 250 volts continuous or 300 volts for five minutes. In increasing the load when

1. The first part of the paper discusses the importance of the study of the history of the English language. It is noted that the English language has a long and rich history, and that the study of its history is essential for a full understanding of the language. The paper then discusses the various factors that have influenced the development of the English language, including the influence of other languages, the influence of social and cultural changes, and the influence of technological advances.

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running at half the normal speed, if the current rises over three hundred amperes strengthen the field and open a few switches. Do not allow the voltage when running at half of normal speed to exceed 125 volts.

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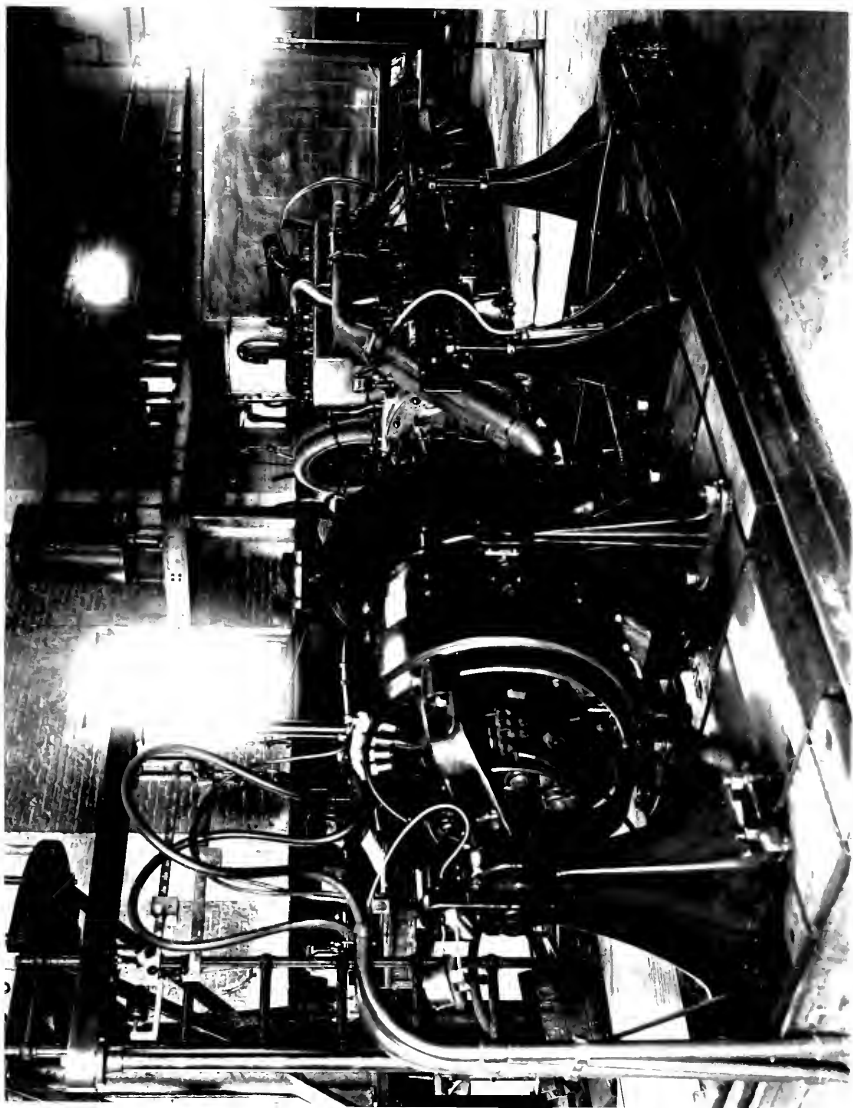
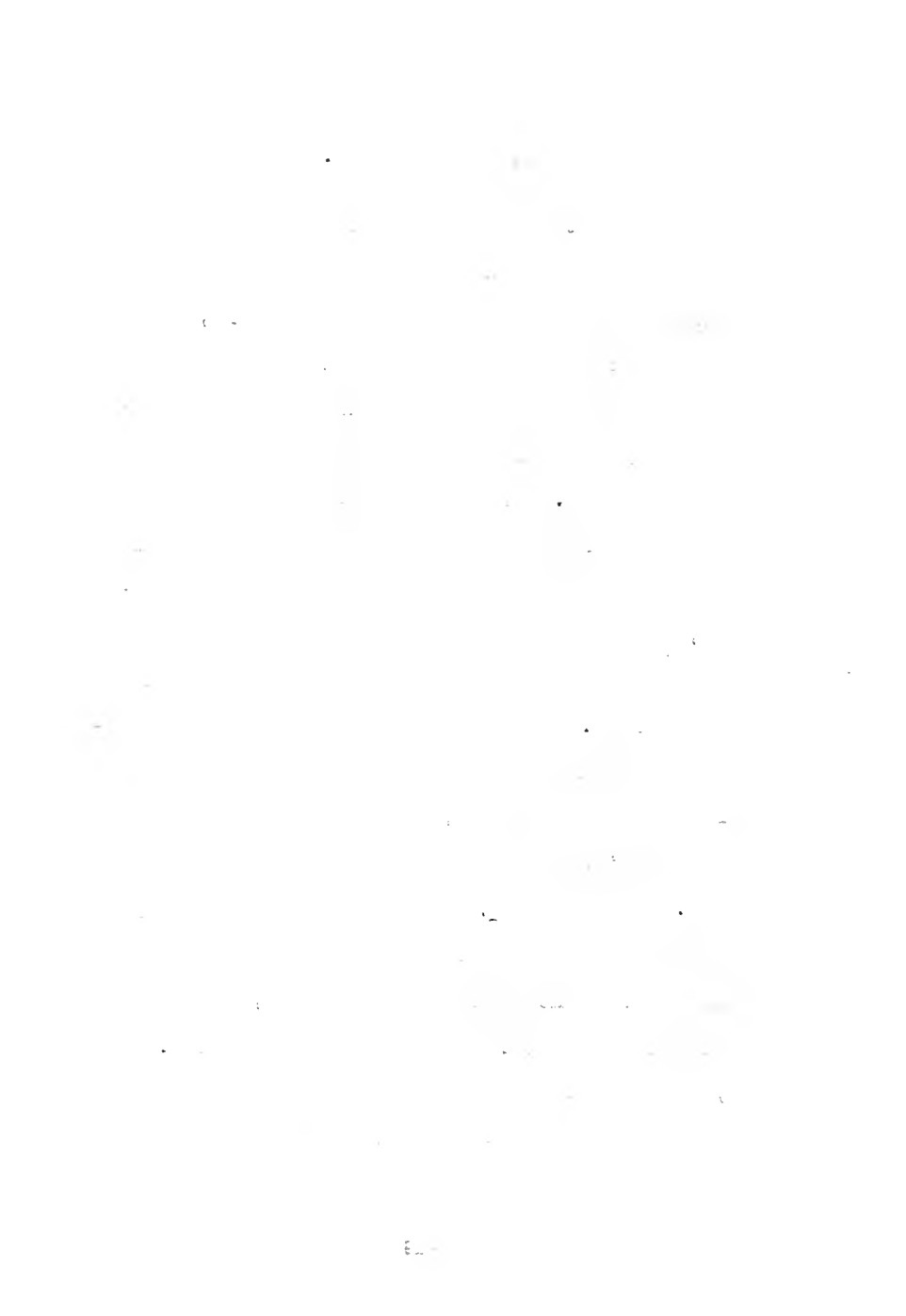


Fig 3

Gas Consumption.

One of the hardest problems presented was that of obtaining accurate fuel consumption for short runs of two or three minutes each, where the amount of fuel consumed was so small as to make it impossible to ascertain the consumption by simply the difference in weight before and after the run. In order to overcome this a gasoline tank was installed as shown in Figure 1

It consisted of an inner and outer cylinder, the inner one capable of holding about two pounds of gasoline and the outer about twenty five pounds. The stop cocks could be so arranged that both tanks would feed the motor at once or just the small one; the latter was found to be sufficient for any of the runs made in the test. As soon as the small tank became empty the stop cock could be opened and the small tank replenished from the large one, after which the connection could again be closed. By a few small gear wheels a float operated a dial which when calibrated, indicated the



amount of gasoline used; this float also indicated through a tall gauge glass the amount of gas in the large cylinder; after a number of calibrations, it was found that for one complete turn of the dial .280 pounds of fuel would run from the tank. The entire apparatus was mounted upon a scale from which amounts of gasoline used both in the calibration of the tank and the tests of the motor could be fairly accurately verified, due to the fact that when the scale beam reached a definite position points on the beam would come in contact with mercury placed in small cups and in so doing complete an electrical circuit causing a bell to ring. Data relative to the calibration of this tank can be found under preliminary observations page 20. This gasoline tank was placed about ten feet from motor and about six feet from the floor level, the connection being made through two flexible tubes connected by a pipe passing underneath the floor.

Cooling Apparatus.

Due to the fact that the motor as tested had no radiator, the cooling water was supplied from a tank placed at the side of motor, best shown in Figure 1. The amount of incoming cold water could be regulated by a valve, while the amount of water pumped by the motor depended of course on the speed of the latter. Data and curves taken on this item are shown later in this thesis, the highest amount taken care of by the pump being nearly 36 gallons per minute at about 1700 R. P. M. The temperature of the inlet and outlet water were taken and in general it was found to be between 100° F. and 150° F.

Manograph.

A manograph or optical gas engine indicator was used in obtaining some of the data. It was driven off the crank shaft and was connected directly to it where the shaft protruded from the front of the motor. Illumination was furnished by a small arc-light focused on the eye piece. It was designed and manufactured by I. Carpentier of Paris, France. This instrument was calibrated with the aid of a compressed air tank of known pressure. The results of this calibration are shown on the manograph cards at the back of this report, while the position of this manograph is best shown in Figure 2 .

The speed counter used was of the simplest type; the counter merely being pushed into the end of dynamometer motor shaft and readings taken for periods of one half minute or minute as the case demanded.

Two mercury manometers were used in this test; one for measuring the pressure at the in-

take manifold and the other placed in the exhaust line, from the front block of cylinders. They were both of the "U" type; the one on the intake manifold being capable of measuring about twenty inches of pressure, while that on the exhaust measured about eight inches pressure. The manometer on the intake manifold was connected by flexible rubber tubing to a small stop-cock which was in turn connected to a small brass pipe brazed on the manifold. The exhaust manometer was simply connected by a curved pipe and flexible tubing, the latter two connected by a small cock.

This concludes the principal apparatus used in this test, such items as the types of thermometers used, watches, etc, are of little consequence in a test of this kind, as it is merely desired to keep things constant for a very short period of time. The maximum time for any run being about three minutes.

PART II.

Observations and Tests made with
Sample Calculations leading
to Definite Results.

Preliminary Observations.

Introduction.

Before the actual test runs were made on the motor several preliminary observations were necessary; briefly speaking, a determination of the range of ignition was made as well as the valve timing. The gasoline tank and water pump were calibrated and the clearance volume of cylinder No. 1 was determined. The method pursued in making these determinations together with the figures resulting from the latter are shown on the following pages.

Determination of the Range of Ignition.

The spark lever was set to the full retard position, after which the engine was turned over by hand until cylinder number one was at top dead center and on the compression stroke. In this position the cylinder was ready to fire its charge of gas. The cover on the breaker box was disconnected and a thin piece of paper inserted between the platinum points, after which the motor was turned backward or forward

QUESTION

- $\frac{1}{1-x^2} = \sum_{n=0}^{\infty} x^{2n}$

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until the points were closed and the paper held securely. The motor was then turned over slowly until the points just released the paper; this was the point of ignition for the retard position of the spark lever. A mark was made on the flywheel opposite the indicator and the distance measured on the flywheel from the mark to the top dead center of the corresponding cylinder. The paper was replaced between the breaker points and the spark lever advanced a trifle. The flywheel was turned back half of a revolution and then brought forward slowly until the points just began to separate. This was the point of ignition for full advance of the spark. A mark was made on the flywheel opposite the indicator as before, and the distance measured from the mark to the top dead center.

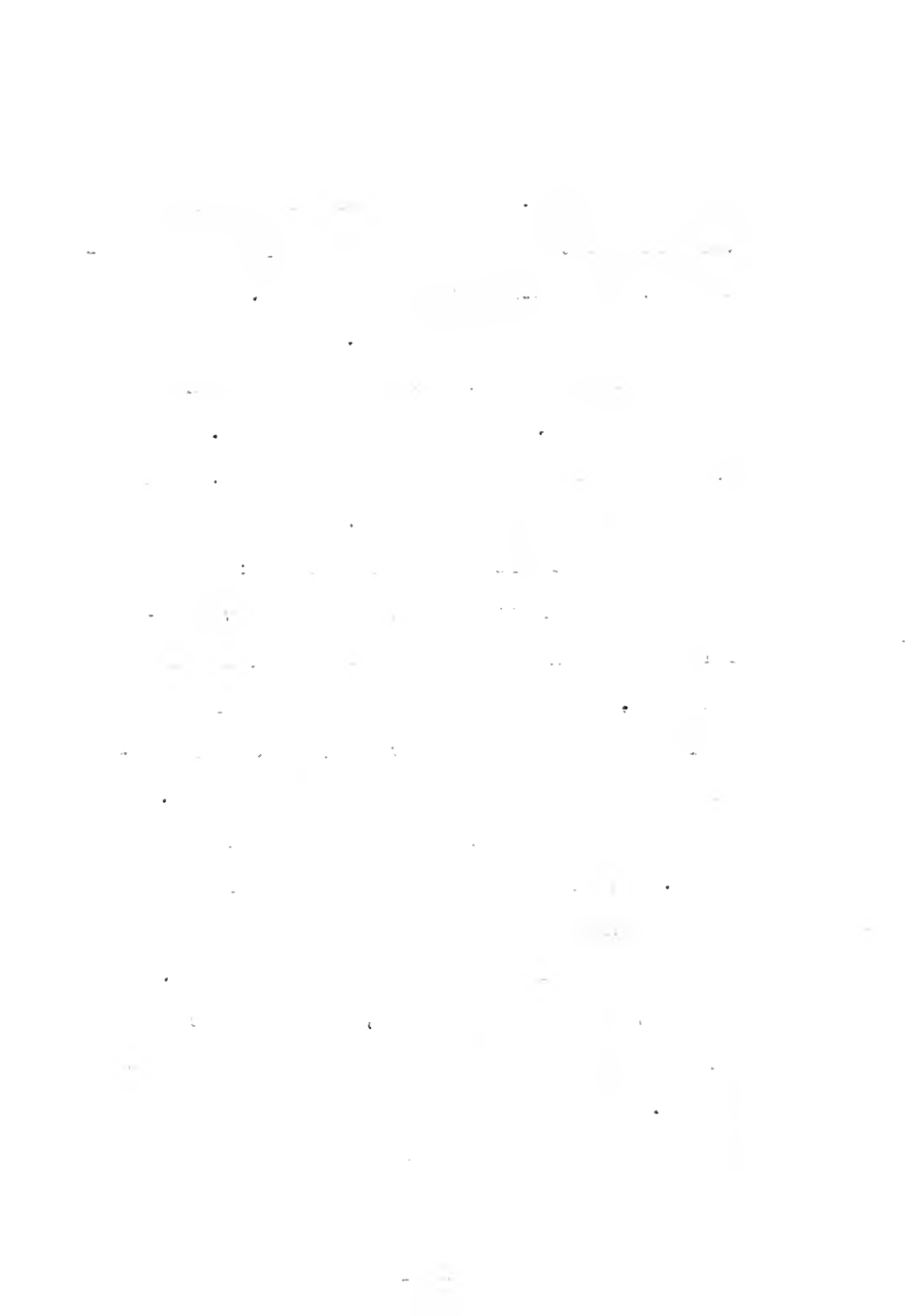
To obtain these results in degrees as was done it was necessary to multiply the distance measured by 360 and divide this by the circumference of the flywheel, the latter being determined by slipping a tape around the outside

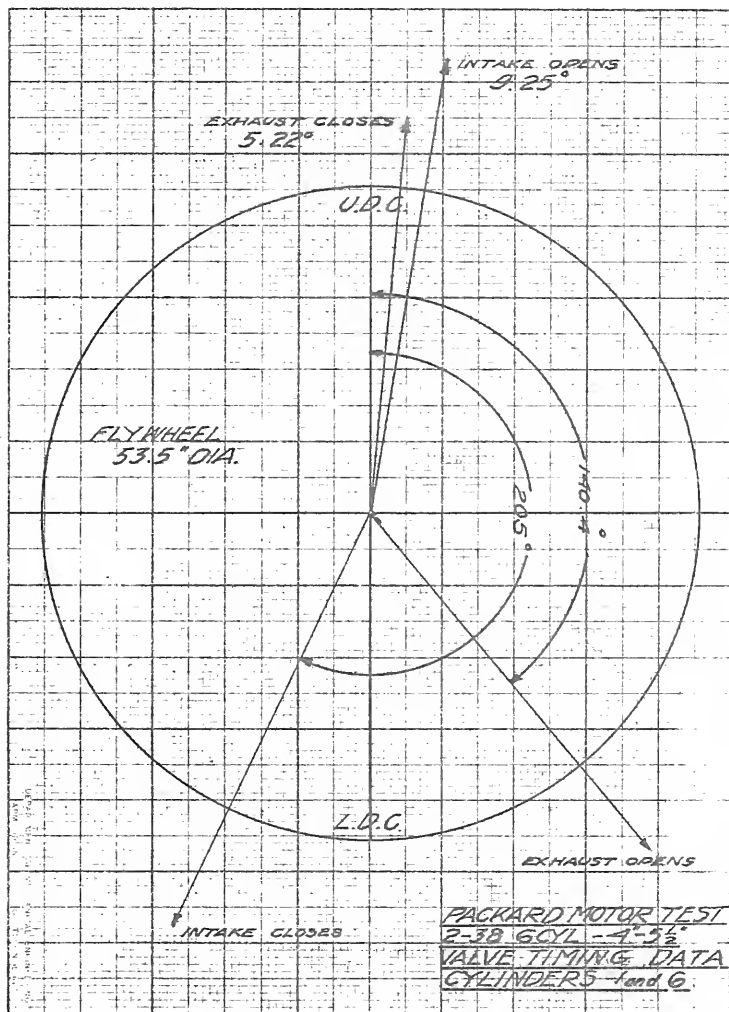
of the flywheel. The spark lever was set at various positions and the points of ignition determined for each position as above.

Valve Timing.

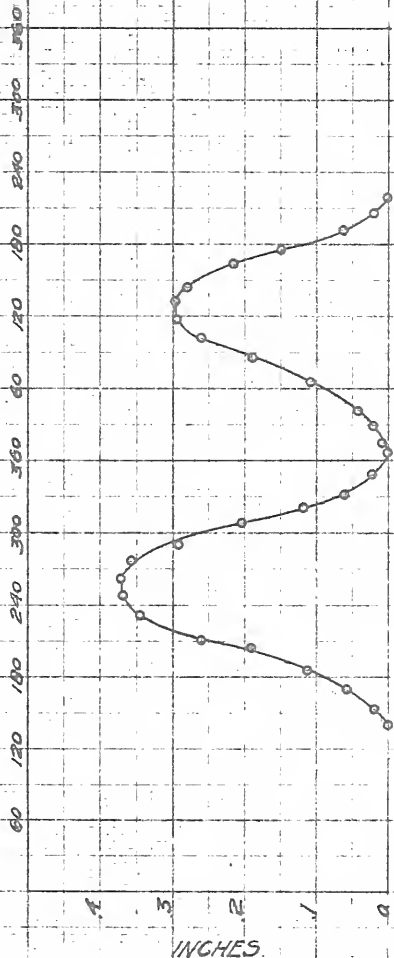
Before the valves were set the clearance was determined. This should be about .004 of an inch on the intake valve and about .005 of an inch on the exhaust valve. The method of setting the clearance was as follows:

A gauge of the proper thickness was inserted between the intake valve stem and the push rod, after which the motor was turned over until the mark "Inlet Valve Opens" on the flywheel appeared opposite the indicator mark. The valve should just begin to open at this point. If the valve should open before the mark on the flywheel and indicator coincide, the length of the push rod can be adjusted. If the valve opens too late, the valve tappets can be adjusted until the right opening is obtained. The engine was then turned over by hand until the stem rested on the low part of





CRANK PIN POSITION



PACARD MOTOR
 2-38-60X 4x5 1/2"
 VALVE LIFT DIAGRAM
 APRIL 9-1915

the cam at which time the thickness gauge should be extracted from the tappets. If the setting was made properly the gauge will just fill the clearance space between the valve stem and push rod.

Data.

Circumference of Flywheel 53-1/2 inches

Intake opens 1-3/8 inches. equals 9.25°
degrees L.U.D.C.

Intake closes 3-3/4 inches L.L.D.C. equals
205 degrees L.U.D.C.

Exhaust opens 19-1/2 equals 140.4° degrees
L. U. D. C.

Exhaust closes 7/8, equals 5.22 degrees
L.U.D.C.

1. The first step is to identify the problem or question that needs to be answered.

2. The second step is to gather relevant information and data.

3. The third step is to analyze the information and data to identify patterns and trends.

4. The fourth step is to develop a hypothesis or solution based on the analysis.

5. The fifth step is to test the hypothesis or solution.

6. The sixth step is to evaluate the results.

7. The seventh step is to draw conclusions and make recommendations.

8. The eighth step is to communicate the findings to the relevant stakeholders.

9. The ninth step is to implement the recommendations.

10. The tenth step is to monitor and evaluate the implementation.

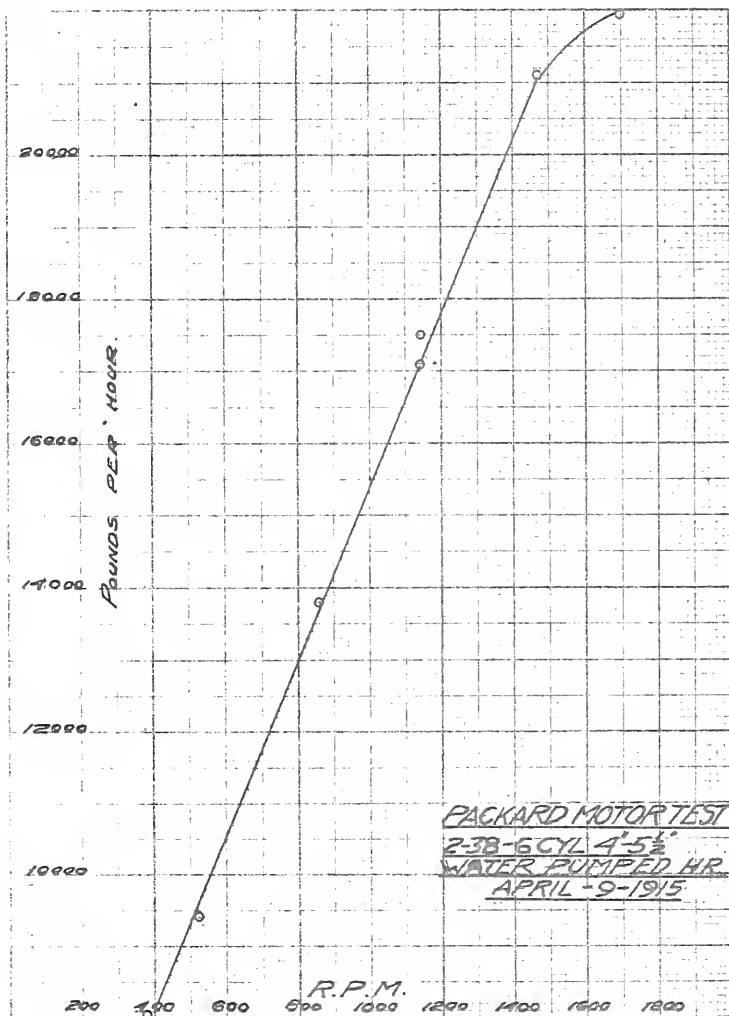
11. The eleventh step is to report on the progress and results.

12. The twelfth step is to review the process and make improvements.

13. The thirteenth step is to document the findings and recommendations.

The same scheme was carried out for the exhaust valve after the clearance had been set, the motor was turned over until the intake valve on any particular cylinder began to open. The distance was measured on the flywheel from top dead center to the mark made as explained above. The motor was again turned over until the exhaust valve began to open and the distance again measured from the mark to the lower dead center. The same procedure was gone through in determining the closing points of the intake and exhaust valves. The results appear below.

The determination of the amount of cooling water pumped at different speeds was made as follows; a three way valve was placed in the outlet line leading from the motor to the cooling water tank. The engine was then run at different speeds and the water coming from the motor was allowed to flow for five seconds into a receptacle placed on weighing scales. In this way the amount of water pumped per minute for each speed was determined by multiplying the



weight of water flowing into the receptacle for five seconds. The data and curve for this determination are shown below.

| R.P. M. | Lbs. | Time sec. |
|---------|-------|-----------|
| 366 | 11.25 | 5 |
| 532 | 13. | 5 |
| 860 | 19.25 | 5 |
| 1004 | 21.5 | 5 |
| 1178 | 23.75 | 5 |
| 1466 | 29.5 | 5 |
| 1532 | 31.5 | 5 |
| 1710 | 30.5 | 5 |

The clearance volume was found by taking a known weight of water, and after removing the cylinder cap and placing the cylinder in question on upper dead center, allowing the water to run into the cylinder until the water just came to the head of the cylinder. By rating the weight of water used, and assuming the density as unity the cubic contents was easily found. Since the bore and stroke of the motor are known the percent clearance volume can be determined by multiplying the ratio of the clearance volume over the cubic displacement by one hundred.

Some difficulty was found in calibrating

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the gasoline tank due to the fact that the small brass gear wheels operating the dial pointer were not smoothly finished and caused the pointer on the dial to stick, thus giving incorrect readings. After this defect had been adjusted the work of calibrating the tank was as described below. The tank was first filled with gasoline and its weight noted. The scale bob was then placed one pound under this weight and the stop cock from the small tank opened and the gasoline allowed to run out. Due to the fact that the scale was electrically connected, a bell was rung the instant the amount of gasoline running from the tank had reached one pound. During this period the number of turns and fraction thereof that the pointer made were noted. These determinations were made a number of times, for different weights of gasoline. From this data the amount of gasoline used for each turn of the pointer could be calculated by dividing the weight of gasoline allowed to run out of the tank, by the number of turns made. From the data obtained it was found that .28 of a

pound of gasoline ran from the tank for each revolution of the pointer. This result may not be absolutely correct, but it is the average of a great many calibrations and therefore may be considered a value which will give fairly accurate results as far as the actual economy of the engine is concerned, and as far as relative economy is concerned between the different throttle pressures it may be considered correct. The latter economy was the one desired in the test.

Calibration.

Gasoline Tank.

| Wt. Lbs. | Turns. | Lbs. Turn. |
|----------|--------|------------|
| 1 | 3.69 | .272 |
| 1 | 3.56 | .281 |
| 1 | 3.54 | .282 |
| 1 | 3.63 | .275 |
| 1 | 3.70 | .270 |
| 2 | 7.15 | .280 |
| 2 | 7.13 | .281 |
| 2 | 7.22 | .278 |
| 2 | 7.17 | .279 |
| 2 | 7.10 | .281 |

Average of the total is equal .28 pounds per turn of the dial.

1. The first step is to identify the problem. In this case, the problem is that the system is not working properly.

2. The next step is to determine the cause of the problem. This can be done by checking the logs and looking for any error messages.

3. Once the cause has been identified, the next step is to develop a solution. This may involve changing some of the system's settings or updating the software.

4. After a solution has been developed, it is important to test it to make sure it works. This can be done by running the system and seeing if the problem is resolved.

5. Finally, it is important to document the solution so that it can be used in the future if the problem occurs again.

The following table shows the results of the tests performed on the system.

| Test Case | Expected Result | Actual Result |
|---------------------------------------|------------------------------------|------------------------------------|
| 1. System starts up correctly | System starts up correctly | System starts up correctly |
| 2. System processes data correctly | System processes data correctly | System processes data correctly |
| 3. System generates reports correctly | System generates reports correctly | System generates reports correctly |
| 4. System handles errors correctly | System handles errors correctly | System handles errors correctly |
| 5. System shuts down correctly | System shuts down correctly | System shuts down correctly |

The results of the tests show that the system is working properly and that the problem has been resolved.

Engine Tests.

The tests of the motor are listed under two general heads, namely: Power and Economy Runs, and Friction Horsepower Runs. The former are eight in number and the latter seven. Besides these two sets of data compression runs for each suction and a number of speeds were made, the curves, manograph cards and data for each of these runs being shown at the back of the thesis.

The tests at the different suctions were run at speeds varying from 300 R. P. M. to 2000 R. P. M., generally five different speeds were taken together with the other items shown on the log sheets. The gasoline consumption was obtained as described under preliminary observation, in almost all cases three readings being obtained in order to check the results. The same might be said of R. P. M. readings, which were generally two in number each being made for 30 seconds.

The friction horsepower runs were made as

described from speeds of 300 R. P. M. to 1000 R. P. M., and the curve for the horse power thereafter assumed. The reader is referred to the discussion of results and curves for a more complete analysis of the results of the test.

The method used in calculating the different items of the log sheet can best be shown by an actual computation. Run No. 1 with wide open throttle will be carried through as a sample computation.

The log sheet shows that the average time required for 664 revolutions of the motor was one minute.

The torque was 173 lbs, which gives the horse power developed as $173 \times 664 \div 4000$, equals 28.8.

The torque in ft. lbs is equal to the torque multiplied by the length of the arm in ft., which gives 173×1.315 equals 227.5.

The friction horsepower as taken from the friction curve is equal to 4.0.

The indicated horsepower then is the sum of the developed or the brake horse power plus

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1

the friction horsepower or 28.8 plus 4.0, equals 32.8 I. H. P.

The Motor used .56 lbs. of gasoline in 88 seconds, or 22.9 lbs. per hour, thus $.56 \times 3600$ equals 22.9 lbs per hour.

The gasoline consumption per B. H. P. is $22.9 \div 28.8$ equals .824 lbs.

The density of the gasoline in degrees Baume was found to be .60.

From the equation for low testing value of gasoline, namely:

B. T. U. per lb. equals 17030 plus 40 (B-10).

Where (B) is the Baume reading, the heating value of the gasoline was found to be 19030 B.

T. U. per lb.

The B. T. U. supplied per hour to the motor is equal to

19030×22.9 equals 436500 B. T. U.

The heat equivalent of one horsepower is 2545 B. T. U. per hour. Then the percent of the total heat which is utilized as B. H. P. is equal to $\frac{2545 \times 28.8}{436500} \times 100$ equals 16.8%.

From the calibration curve of the water pump we find that it circulates 11250 lbs of water per hour at the above speed.

The temperature difference was equal to 9 degrees Fahrenheit, hence the heat lost to cooling water is equal to 9 X 11250 equals 101250 B. T. U. and the percentage of heat lost to the jacket water is equal to

$$\frac{101250 \times 100}{436500} \text{ equals } 26.1$$

Of the total heat supplied 45. 1% has been accounted for, leaving 57.1% lost to radiation, exhaust, etc.

1. The first part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function, and its value is determined by the initial condition $f(0) = 1$. The second part of the paper is devoted to the study of the properties of the function $g(x)$ defined by the equation $g(x) = \int_0^x g(t) dt$. It is shown that $g(x)$ is a constant function, and its value is determined by the initial condition $g(0) = 1$. The third part of the paper is devoted to the study of the properties of the function $h(x)$ defined by the equation $h(x) = \int_0^x h(t) dt$. It is shown that $h(x)$ is a constant function, and its value is determined by the initial condition $h(0) = 1$.

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Discussion of Results from Motor Tests.

The data and curves resulting from the tests of the motor show clearly that a distinct relation exists between the suction pressure and the power and economy.

The economy curves show the following facts, that the gasoline consumption per hour decreases with the mercury depression, but at the same time the actual gasoline consumption per B. H. P. hour increases with the mercury depression.

In regard to the power, it can be said that the torque, B. H. P. and I. H. P. decrease an appreciable amount for each increase in the intake depression. The best B. H. P. obtained during the entire test was sixty three, the latter remaining almost constant from 1700 R. P. M. to 2000 R. P. M.

The M. E. P. - R. P. M. curves show the same tendency as the H. P. curves, namely, that of decreasing as the depression increases, the maximum M. E. P. for each suction being

105-21-70-00

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reached from the speeds of 600 R. P. M. to 800 R. P. M.

The mechanical efficiency curves are especially interesting, due to the wide range of value obtained, the wide open throttle run showing an efficiency of 73% at 1800 R. P. M. and 89% at 400 R. P. M., while the 16inch suction shows values ranging from 10% to 63% for the same speeds as above.

In the matter of efficiency, the thermal, heat lost in cooling water and the heat lost in the exhaust evidently do not follow any direct law, but are influenced by outside conditions which cannot be altered and the result therefore could not be discussed with any degree of satisfaction, except to say that the thermal efficiency and heat lost in the exhaust are of values generally accepted as correct in motor practice.

From the manograph cards shown, one common fault is at once noticeable, that of slow burning of the gases. This is, however, to be expected from the type of motor used, as it is considered an inherent fault of the "L" head

$\mu = \frac{1}{n} \sum_{j=1}^n x_j$

• • •

100

1. *How many people are there in your family?*

—

type of motor.

From the compression cards it can be seen that the compression increases as the suction depression decreases, and also that the general form of the curve drawn through the highest points of the compression lines follows very closely the torque curves spoken of on a former page.

In conclusion the reader is referred to the numerous curves and log sheets appearing at the back of this thesis, and which show more clearly than can be described not only the little individual characteristics of each suction and speed, but also the relation which exists between the suction depression and the power and economy.

PART III.

Data sheets.

Curves.

Manograph Cards.

1. The first step is to identify the problem.

2. The second step is to define the problem.

3. The third step is to analyze the problem.

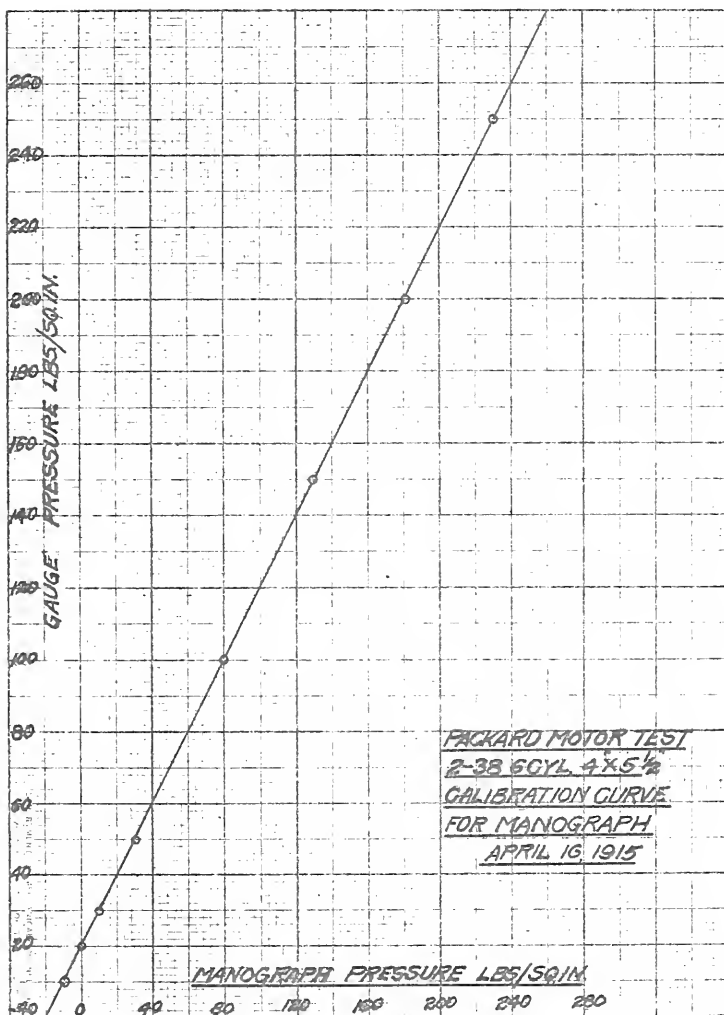
4. The fourth step is to develop a solution.

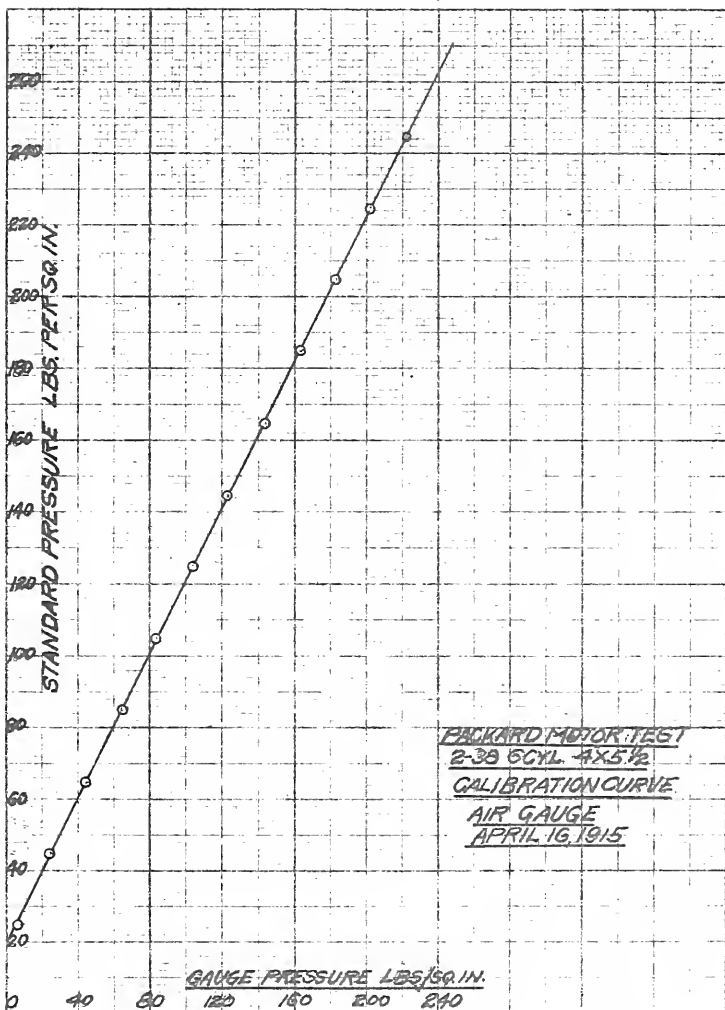
5. The fifth step is to implement the solution.

6. The sixth step is to evaluate the solution.

7. The seventh step is to monitor the solution.

8. The eighth step is to report the results.

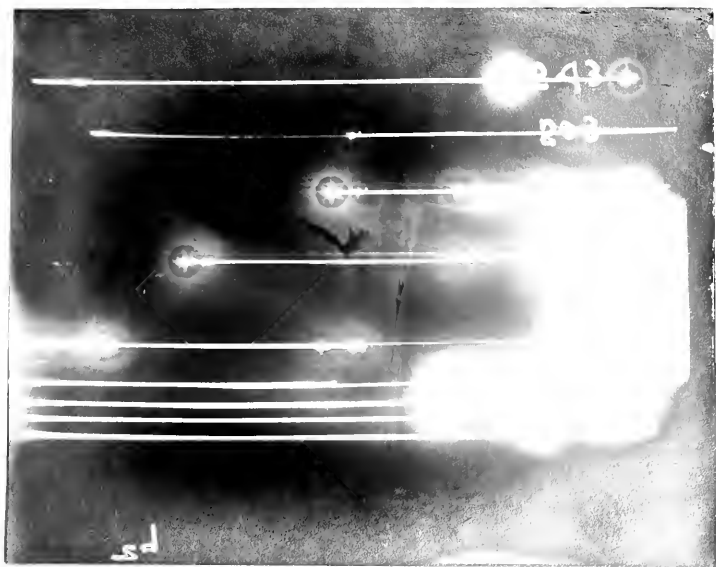


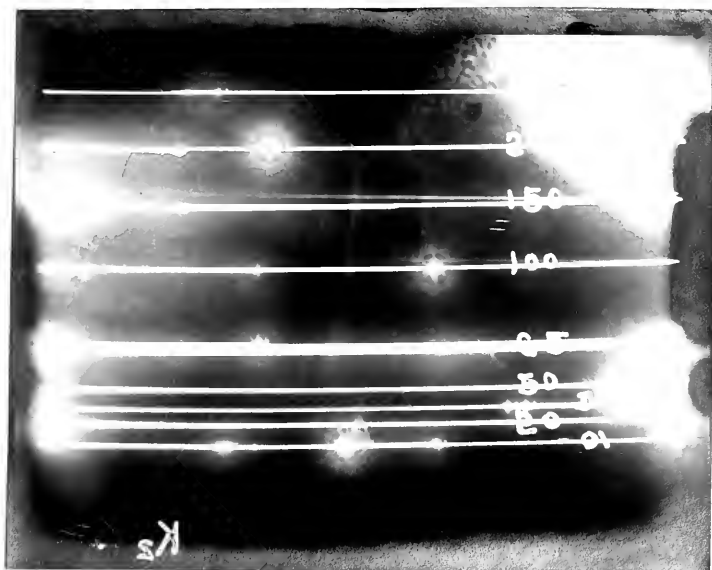


Calibration Card

Pressure

10
20
30
50
65
100
150
203
243





Calibration Card

Pressure

10
20
30
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100
150
203
243

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and Curves.

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| No. 14. 16 inch Hg. Suction | 51 |

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185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 | 420 | 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 450 | 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 | 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 | 511 | 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 540 | 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 | 640 | 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 | 661 | 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 | 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 | 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 | 701 | 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 | 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 | 736 | 737 | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 | 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 779 | 780 | 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 | 800 | 801 | 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 | 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 | 830 | 831 | 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 | 841 | 842 | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 852 | 853 | 854 | 855 | 856 | 857 | 858 | 859 | 860 | 861 | 862 | 863 | 864 | 865 | 866 | 867 | 868 | 869 | 870 | 871 | 872 | 873 | 874 | 875 | 876 | 877 | 878 | 879 | 880 | 881 | 882 | 883 | 884 | 885 | 886 | 887 | 888 | 889 | 890 | 891 | 892 | 893 | 894 | 895 | 896 | 897 | 898 | 899 | 900 | 901 | 902 | 903 | 904 | 905 | 906 | 907 | 908 | 909 | 910 | 911 | 912 | 913 | 914 | 915 | 916 | 917 | 918 | 919 | 920 | 921 | 922 | 923 | 924 | 925 | 926 | 927 | 928 | 929 | 930 | 931 | 932 | 933 | 934 | 935 | 936 | 937 | 938 | 939 | 940 | 941 | 942 | 943 | 944 | 945 | 946 | 947 | 948 | 949 | 950 | 951 | 952 | 953 | 954 | 955 | 956 | 957 | 958 | 959 | 960 | 961 | 962 | 963 | 964 | 965 | 966 | 967 | 968 | 969 | 970 | 971 | 972 | 973 | 974 | 975 | 976 | 977 | 978 | 979 | 980 | 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 | 991 | 992 | 993 | 994 | 995 | 996 | 997 | 998 | 999 | 1000 | 1001 | 1002 | 1003 | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 | 1011 | 1012 | 1013 | 1014 | 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1158 | 1159 | 1160 | 1161 | 1162 | 1163 | 1164 | 1165 | 1166 | 1167 | 1168 | 1169 | 1170 | 1171 | 1172 | 1173 | 1174 | 1175 | 1176 | 1177 | 1178 | 1179 | 1180 | 1181 | 1182 | 1183 | 1184 | 1185 | 1186 | 1187 | 1188 | 1189 | 1190 | 1191 | 1192 | 1193 | 1194 | 1195 | 1196 | 1197 | 1198 | 1199 | 1200 | 1201 | 1202 | 1203 | 1204 | 1205 | 1206 | 1207 | 1208 | 1209 | 1210 | 1211 | 1212 | 1213 | 1214 | 1215 | 1216 | 1217 | 1218 | 1219 | 1220 | 1221 | 1222 | 1223 | 1224 | 1225 | 1226 | 1227 | 1228 | 1229 | 1230 | 1231 | 1232 | 1233 | 1234 | 1235 | 1236 | 1237 | 1238 | 1239 | 1240 | 1241 | 1242 | 1243 | 1244 | 1245 | 1246 | 1247 | 1248 | 1249 | 1250 | 1251 | 1252 | 1253 | 1254 | 1255 | 1256 | 1257 | 1258 | 1259 | 1260 | 1261 | 1262 | 1263 | 1264 | 1265 | 1266 | 1267 | 1268 | 1269 | 1270 | 1271 | 1272 | 1273 | 1274 | 1275 | 1276 | 1277 | 1278 | 1279 | 1280 | 1281 | 1282 | 1283 | 1284 | 1285 | 1286 | 1287 | 1288 | 1289 | 1290 | 1291 | 1292 | 1293 | 1294 | 1295 | 1296 | 1297 | 1298 | 1299 | 1300 | 1301 | 1302 | 1303 | 1304 | 1305 | 1306 | 1307 | 1308 | 1309 | 1310 | 1311 | 1312 | 1313 | 1314 | 1315 | 1316 | 1317 | 1318 | 1319 | 1320 | 1321 | 1322 | 1323 | 1324 | 1325 | 1326 | 1327 | 1328 | 1329 | 1330 | 1331 | 1332 | 1333 | 1334 | 1335 | 1336 | 1337 | 1338 | 1339 | 1340 | 1341 | 1342 | 1343 | 1344 | 1345 | 1346 | 1347 | 1348 | 1349 | 1350 | 1351 | 1352 | 1353 | 1354 | 1355 | 1356 | 1357 | 1358 | 1359 | 1360 | 1361 | 1362 | 1363 | 1364 | 1365 | 1366 | 1367 | 1368 | 1369 | 1370 | 1371 | 1372 | 1373 | 1374 | 1375 | 1376 | 1377 | 1378 | 1379 | 1380 | 1381 | 1382 | 1383 | 1384 | 1385 | 1386 | 1387 | 1388 | 1389 | 1390 | 1391 | 1392 | 1393 | 1394 | 1395 | 1396 | 1397 | 1398 | 1399 | 1400 | 1401 | 1402 | 1403 | 1404 | 1405 | 1406 | 1407 | 1408 | 1409 | 1410 | 1411 | 1412 | 1413 | 1414 | 1415 | 1416 | 1417 | 1418 | 1419 | 1420 | 1421 | 1422 | 1423 | 1424 | 1425 | 1426 | 1427 | 1428 | 1429 | 1430 | 1431 | 1432 | 1433 | 1434 | 1435 | 1436 | 1437 | 1438 | 1439 | 1440 | 1441 | 1442 | 1443 | 1444 | 1445 | 1446 | 1447 | 1448 | 1449 | 1450 | 1451 | 1452 | 1453 | 1454 | 1455 | 1456 | 1457 | 1458 | 1459 | 1460 | 1461 | 1462 | 1463 | 1464 | 1465 | 1466 | 1467 | 1468 | 1469 | 1470 | 1471 | 1472 | 1473 | 1474 | 1475 | 1476 | 1477 | 1478 | 1479 | 1480 | 1481 | 1482 | 1483 | 1484 | 1485 | 1486 | 1487 | 1488 | 1489 | 1490 | 1491 | 1492 | 1493 | 1494 | 1495 | 1 |
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185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 | 420 | 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 450 | 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 | 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 | 511 | 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 540 | 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 | 640 | 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 | 661 | 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 | 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 | 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 | 701 | 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 | 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 | 736 | 737 | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 | 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 779 | 780 | 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 | 800 | 801 | 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 | 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 | 830 | 831 | 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 | 841 | 842 | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 852 | 853 | 854 | 855 | 856 | 857 | 858 | 859 | 860 | 861 | 862 | 863 | 864 | 865 | 866 | 867 | 868 | 869 | 870 | 871 | 872 | 873 | 874 | 875 | 876 | 877 | 878 | 879 | 880 | 881 | 882 | 883 | 884 | 885 | 886 | 887 | 888 | 889 | 890 | 891 | 892 | 893 | 894 | 895 | 896 | 897 | 898 | 899 | 900 | 901 | 902 | 903 | 904 | 905 | 906 | 907 | 908 | 909 | 910 | 911 | 912 | 913 | 914 | 915 | 916 | 917 | 918 | 919 | 920 | 921 | 922 | 923 | 924 | 925 | 926 | 927 | 928 | 929 | 930 | 931 | 932 | 933 | 934 | 935 | 936 | 937 | 938 | 939 | 940 | 941 | 942 | 943 | 944 | 945 | 946 | 947 | 948 | 949 | 950 | 951 | 952 | 953 | 954 | 955 | 956 | 957 | 958 | 959 | 960 | 961 | 962 | 963 | 964 | 965 | 966 | 967 | 968 | 969 | 970 | 971 | 972 | 973 | 974 | 975 | 976 | 977 | 978 | 979 | 980 | 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 | 991 | 992 | 993 | 994 | 995 | 996 | 997 | 998 | 999 | 1000 | 1001 | 1002 | 1003 | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 | 1011 | 1012 | 1013 | 1014 | 1015 | 1016 | 1017 | 1018 | 1019 | 1020 | 1021 | 1022 | 1023 | 1024 | 1025 | 1026 | 1027 | 1028 | 1029 | 1030 | 1031 | 1032 | 1033 | 1034 | 1035 | 1036 | 1037 | 1038 | 1039 | 1040 | 1041 | 1042 | 1043 | 1044 | 1045 | 1046 | 1047 | 1048 | 1049 | 1050 | 1051 | 1052 | 1053 | 1054 | 1055 | 1056 | 1057 | 1058 | 1059 | 1060 | 1061 | 1062 | 1063 | 1064 | 1065 | 1066 | 1067 | 1068 | 1069 | 1070 | 1071 | 1072 | 1073 | 1074 | 1075 | 1076 | 1077 | 1078 | 1079 | 1080 | 1081 | 1082 | 1083 | 1084 | 1085 | 1086 | 1087 | 1088 | 1089 | 1090 | 1091 | 1092 | 1093 | 1094 | 1095 | 1096 | 1097 | 1098 | 1099 | 1100 | 1101 | 1102 | 1103 | 1104 | 1105 | 1106 | 1107 | 1108 | 1109 | 1110 | 1111 | 1112 | 1113 | 1114 | 1115 | 1116 | 1117 | 1118 | 1119 | 1120 | 1121 | 1122 | 1123 | 1124 | 1125 | 1126 | 1127 | 1128 | 1129 | 1130 | 1131 | 1132 | 1133 | 1134 | 1135 | 1136 | 1137 | 1138 | 1139 | 1140 | 1141 | 1142 | 1143 | 1144 | 1145 | 1146 | 1147 | 1148 | 1149 | 1150 | 1151 | 1152 | 1153 | 1154 | 1155 | 1156 | 1157 | 1158 | 1159 | 1160 | 1161 | 1162 | 1163 | 1164 | 1165 | 1166 | 1167 | 1168 | 1169 | 1170 | 1171 | 1172 | 1173 | 1174 | 1175 | 1176 | 1177 | 1178 | 1179 | 1180 | 1181 | 1182 | 1183 | 1184 | 1185 | 1186 | 1187 | 1188 | 1189 | 1190 | 1191 | 1192 | 1193 | 1194 | 1195 | 1196 | 1197 | 1198 | 1199 | 1200 | 1201 | 1202 | 1203 | 1204 | 1205 | 1206 | 1207 | 1208 | 1209 | 1210 | 1211 | 1212 | 1213 | 1214 | 1215 | 1216 | 1217 | 1218 | 1219 | 1220 | 1221 | 1222 | 1223 | 1224 | 1225 | 1226 | 1227 | 1228 | 1229 | 1230 | 1231 | 1232 | 1233 | 1234 | 1235 | 1236 | 1237 | 1238 | 1239 | 1240 | 1241 | 1242 | 1243 | 1244 | 1245 | 1246 | 1247 | 1248 | 1249 | 1250 | 1251 | 1252 | 1253 | 1254 | 1255 | 1256 | 1257 | 1258 | 1259 | 1260 | 1261 | 1262 | 1263 | 1264 | 1265 | 1266 | 1267 | 1268 | 1269 | 1270 | 1271 | 1272 | 1273 | 1274 | 1275 | 1276 | 1277 | 1278 | 1279 | 1280 | 1281 | 1282 | 1283 | 1284 | 1285 | 1286 | 1287 | 1288 | 1289 | 1290 | 1291 | 1292 | 1293 | 1294 | 1295 | 1296 | 1297 | 1298 | 1299 | 1300 | 1301 | 1302 | 1303 | 1304 | 1305 | 1306 | 1307 | 1308 | 1309 | 1310 | 1311 | 1312 | 1313 | 1314 | 1315 | 1316 | 1317 | 1318 | 1319 | 1320 | 1321 | 1322 | 1323 | 1324 | 1325 | 1326 | 1327 | 1328 | 1329 | 1330 | 1331 | 1332 | 1333 | 1334 | 1335 | 1336 | 1337 | 1338 | 1339 | 1340 | 1341 | 1342 | 1343 | 1344 | 1345 | 1346 | 1347 | 1348 | 1349 | 1350 | 1351 | 1352 | 1353 | 1354 | 1355 | 1356 | 1357 | 1358 | 1359 | 1360 | 1361 | 1362 | 1363 | 1364 | 1365 | 1366 | 1367 | 1368 | 1369 | 1370 | 1371 | 1372 | 1373 | 1374 | 1375 | 1376 | 1377 | 1378 | 1379 | 1380 | 1381 | 1382 | 1383 | 1384 | 1385 | 1386 | 1387 | 1388 | 1389 | 1390 | 1391 | 1392 | 1393 | 1394 | 1395 | 1396 | 1397 | 1398 | 1399 | 1400 | 1401 | 1402 | 1403 | 1404 | 1405 | 1406 | 1407 | 1408 | 1409 | 1410 | 1411 | 1412 | 1413 | 1414 | 1415 | 1416 | 1417 | 1418 | 1419 | 1420 | 1421 | 1422 | 1423 | 1424 | 1425 | 1426 | 1427 | 1428 | 1429 | 1430 | 1431 | 1432 | 1433 | 1434 | 1435 | 1436 | 1437 | 1438 | 1439 | 1440 | 1441 | 1442 | 1443 | 1444 | 1445 | 1446 | 1447 | 1448 | 1449 | 1450 | 1451 | 1452 | 1453 | 1454 | 1455 | 1456 | 1457 | 1458 | 1459 | 1460 | 1461 | 1462 | 1463 | 1464 | 1465 | 1466 | 1467 | 1468 | 1469 | 1470 | 1471 | 1472 | 1473 | 1474 | 1475 | 1476 | 1477 | 1478 | 1479 | 1480 | 1481 | 1482 | 1483 | 1484 | 1485 | 1486 | 1487 | 1488 | 1489 | 1490 | 1491 | 1492 | 1493 | 1494 | 1495 | 1 |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-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Curves (cont).

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| | Friction Horsepower. | |
| 27 | Wide open throttle. | 71 |
| 28 | 2 inch and 3 inch suction. | 72 |
| 29 | 6 inch and 10 inch suction. | 73 |
| 30 | 14 inch and 16 inch suction. | 74 |
| | Wiring Diagram 100 H. P. | Last Page. |
| | Sprague Dynamometer. | |



PACKARD MOTOR TEST

OBJECT: POWER & ECONOMY

SUCTION - WIDE OPEN THROTTLE

TEST NO. 1

MOTOR 2-38"

6 CYL. 4 X 5 1/2"

NO. 53554

DATE: APRIL 7, 1915

BAR 29.40 IN. HG.

TEMP 65 DEG. F.

GASOLINE 60° B at 67° F.

| RUN NO. | R.P.M. | TORQ. | B.H.P. | F.H.P. | B.H.P. + F.H.P. | M.E. | M.E.P. NET | TEMP. COOL. WATER DEG. F. | | PRESSURES IN. HG. | | JACKET WATER | | GAS CONSUMPTION | | THER. EFF. % | HEAT ABS. IN. WATER | | HEAT EXH. RAD. ETC. % | POS. SPARK ADV. |
|---------|--------|-------|--------|--------|-----------------|------|------------|---------------------------|--------|-------------------|---------|--------------|----------------|-----------------|------------------|--------------|---------------------|------|-----------------------|-----------------|
| | | | | | | | | INLET | OUTLET | INTAKE | EXHAUST | LBS. PER HR. | G.T.W. PER HR. | LBS. PER HR. | LBS. PER BHP-HR. | | % | % | | |
| 1 | 664 | 173 | 288 | 4.0 | 32.8 | 87.7 | 82.8 | 111 | 120 | 1/2 | — | 11250 | 101250 | 22.9 | 824 | 168 | 26.1 | 57.1 | 24 | |
| 2 | 992 | 175 | 435 | 8.5 | 52.0 | 83.7 | 83.8 | 118 | 126 | 1 1/8 | — | 15250 | 122000 | 356 | 819 | 163 | 18.1 | 65.6 | 28 | |
| 3 | 1361 | 157.5 | 536 | 14.9 | 68.5 | 78.2 | 75.3 | 115 | 122 | 1 5/8 | — | 20700 | 145000 | 393 | 792 | 18.2 | 19.5 | 62.3 | 36 | |
| 4 | 1513 | 156.5 | 593 | 17.5 | 76.8 | 77.2 | 74.8 | 110 | 117 | 1 3/4 | — | 21200 | 143900 | 54.2 | 746 | 16.4 | 16.1 | 67.5 | 39 | |
| 5 | 1747 | 139 | 60.7 | 23.0 | 83.7 | 72.5 | 66.4 | 109 | 117 | 2 1/8 | — | 22000 | 176000 | 48.3 | 797 | 16.3 | 18.5 | 65.2 | 40 | |
| 6 | 1940 | 119 | 57.7 | 28.0 | 85.7 | 67.3 | 56.8 | 109 | 116 | 2 1/4 | — | 22000 | 154000 | 50.0 | 867 | 14.2 | 15.0 | 70.8 | 40 | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
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PACKARD MOTOR TEST

OBJECT: POWER

SUCTION- WIDE OPEN THROTTLE

TEST NO. 15

MOTOR 2-38

GCYL. 4 X 5 1/2"

NO. 53554

DATE: APRIL 16, 1915

BAR 29.48 IN. HG.

TEMP 68 DEG. F.

GASOLINE 60°B at 67°F.

| RUN NO | TORR | B.H.P. | F.H.P. | B.H.P. + F.H.P. | M.E. | M.E.P. NET | TEMP COOL. WATER DEG. F. | | JACKET WATER | | PRESSURE'S IN HG. | | POS SPARK ADV |
|-----------|------|--------|--------|-----------------------|------|---------------|--------------------------------|--------|------------------|--------------------------|----------------------|--------|---------------------|
| | | | | | | | INLET | OUTLET | LES PER HR | LES ABS. PER HR | INTAKE | EXH. | |
| 1 | 641 | 174 | 27.9 | 4.0 | 31.9 | 87.5 | 94 | 101 | 11000 | 77000 | 1/2 | 3/8 | 30 |
| 2 | 809 | 175 | 35.8 | 6.0 | 41.8 | 85.7 | 99.5 | 109.5 | 13000 | 130000 | 13/16 | 1 1/16 | 32.5 |
| 3 | 1236 | 162 | 50 | 12.5 | 62.5 | 80 | 109.5 | 116.5 | 18150 | 121000 | 1 3/8 | 1 | 34 |
| 4 | 1400 | 162 | 56.8 | 15.5 | 72.3 | 78.6 | 94 | 102 | 20200 | 161600 | 1 3/8 | 1 3/8 | 42 |
| 5 | 1204 | 167.5 | 50.5 | 12.0 | 62.5 | 80.7 | 92 | 101 | 17800 | 160200 | 1 5/8 | 1 1/8 | 39 |
| 6 | 1554 | 159.5 | 61.9 | 18.5 | 80.4 | 77 | 102 | 108 | 21500 | 129000 | 1 5/8 | 2 3/16 | 43 |
| 7 | 1620 | 153.9 | 62.1 | 20.0 | 82.1 | 75.6 | 108 | 116 | 21800 | 174400 | 1 7/8 | 2 3/16 | 45 |
| 8 | 1758 | 142 | 62.5 | 23.0 | 85.5 | 73 | 117 | 122.5 | 22000 | 176000 | 1 5/8 | 2 3/4 | 45 |
| 9 | 1842 | 139.5 | 62 | 25.1 | 87.0 | 71.3 | 118 | 125.5 | 22000 | 220000 | 1 7/8 | 2 3/8 | 45 |
| 10 | 1940 | 129.5 | 62.8 | 28.0 | 90.8 | 64.2 | 97 | 106 | 22000 | 198000 | 1 7/8 | 3 3/8 | 45 |

PACKARD MOTOR TEST

OBJECT: POWER & ECONOMY

SECTION 2" H.G.

TEST NO. 2

MOTOR 2-38

6 CYL 4" X 5 1/2"

NO. 53554

DATE: APRIL 9, 1915

BAR. 29.40 IN. HG.

TEMP. 65 DEG. F.

GASOLINE 60° B at 67°F.

| RUN NO. | R.P.M. | TORQ. | B.H.P. | F.H.P. | B.H.P. + F.H.P. | M.E. NET | TEMP. COOL. WATER DEG. F. | | PRESSURES IN. HG. | | JACKET WATER | | GAS CONSUMPTION | | THER. EFF. % | HEAT ABS. IN. JACKET EXH. WATER RAD. ETC. % | HEAT ABS. IN. SPARK ADV. | POS. |
|---------|--------|-------|--------|--------|-----------------|----------|---------------------------|--------|-------------------|---------|---------------|-------------------|-----------------|--------------|--------------|---|--------------------------|------|
| | | | | | | | INLET | OUTLET | INTAKE | EXHAUST | LBS. PER HOUR | BTU ABS. PER HOUR | LBS. PER HOUR | BTU PER HOUR | | | | |
| 1 | 628 | 169 | 26.5 | 4.0 | 30.5 | 86.8 | 106 | 113.5 | 2 | 1 1/2 | 10900 | 81750 | 18.61 | 703 | 19.0 | 23.1 | 57.9 | 28° |
| 2 | 818 | 170.5 | 34.85 | 5.5 | 40.36 | 86.5 | 120 | 130.3 | 2 | 1 1/6 | 13200 | 132000 | 23.44 | 67 | 19.9 | 29.6 | 50.6 | 32° |
| 3 | 1418 | 158.5 | 56.2 | 16.5 | 72.7 | 77.3 | 118 | 127.3 | 2 | 1 1/2 | 20500 | 184500 | 40.42 | 718 | 18.66 | 24.1 | 57.24 | 34° |
| 4 | 1694 | 148.5 | 62.9 | 23.0 | 85.9 | 73.2 | 104 | 113.3 | 2 | 3 | 22000 | 198000 | 46.8 | 744 | 18.0 | 22.25 | 59.8 | 40° |
| 5 | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | |

PACKARD MOTOR TEST

OBJECT: POWER & ECONOMY

SUCTION 14" Hg.

TEST NO. 6

MOTOR 2-38

6 CYL. 4" x 5 1/2"

NO. 53554

DATE: APRIL 9, 1915

BAR 29.40 IN. Hg.

TEMP 65° DEG. F.

GASOLINE 60° B at 67° F.

| RUN NO. | RPM | TORQ | B.H.P. | F.H.P. | M.E. | MER NET | TEMP COOL. WATER DEG. F. | | PRESSURES IN HG. | | JACKET WATER | | GAS CONSUMPTION | | THER EFF. % | HEAT IN JACKET WATER % | HEAT IN EXH. RAD. % | POS SPARK ADV. |
|------------|------|------|--------|--------|-------|------------|--------------------------------|--------|---------------------|---------|-----------------|-------------------|--------------------|---------------------|-------------------|------------------------------------|---------------------------------|----------------------|
| | | | | | | | INLET | OUTLET | INTAKE | EXHAUST | LS. HR. | WT. PER HR. | LS. PER HR. | WT. PER HP-HR | | | | |
| 1 | 572 | 64.5 | 9.22 | 4.5 | 13.72 | 67.1 | 115 | 122 | 14 | 3/32 | 10100 | 70700 | 10.87 | 118 | 11.33 | 34.2 | 54.5 | 40 |
| 2 | 772 | 61.0 | 11.75 | 7.0 | 18.75 | 62.6 | 118 | 126 | 14 | 5/16 | 12600 | 101000 | 11.66 | .98 | 13.55 | 45.0 | 41.5 | 40 |
| 3 | 1082 | 44.5 | 12.01 | 12.0 | 24.01 | 50.0 | 102 | 109 | 14 | 1/4 | 16350 | 114300 | 14.94 | 1.24 | 10.74 | 40.2 | 49.1 | 40 |
| 4 | 1322 | 40.0 | 13.22 | 17.0 | 30.22 | 43.8 | 96 | 103 | 14 | 1/32 | 19500 | 136300 | 18.0 | 1.37 | 9.51 | 33.8 | 50.7 | 40 |
| 5 | 1609 | 32.5 | 13.1 | 23.5 | 36.6 | 35.5 | 119 | 123 | 14 | 9/16 | 21200 | 84800 | 19.5 | 1.48 | 9.04 | 22.8 | 68.1 | 40 |
| 6 | 1794 | 9.5 | 4.26 | 29.0 | 33.26 | 12.8 | 123 | 133 | 14 | 9/16 | 22000 | 220000 | 18.36 | 4.3 | 3.09 | 62.9 | 34.0 | 40 |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
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PACKARD MOTOR TEST

OBJECT: POWER & ECONOMY

SUCTION 16" Hg.

TEST NC. 7

MOTOR 2-38

6 CYL. 4 X 5 1/2

NO. 53554

DATE: APRIL 9, 1915

BAR. 29.40 IN. Hg.

TEMP. 65° DEG. F.

GASOLINE 60° Bat 67° F.

| RUN NO | R.P.M. | TORQ | B.H.P. | F.H.P. | M.E. | M.F.P. NET | TEMP. COOL. WATER DEG. F. | | PRESSURES IN. Hg. | | JACKET WATER | | GAS CONSUMPTION | | THER EFF. % | HEAT IN. JACKET WATER % | HEAT EXH. RAD. ETC. % | POS. SPARK ADV. |
|--------|--------|------|--------|--------|-------|------------|---------------------------|--------|-------------------|---------|--------------|-------------------|-----------------|------------|-------------|-------------------------|-----------------------|-----------------|
| | | | | | | | INLET | OUTLET | INTAKE | EXHAUST | LBS. PER HR. | RTU. ABS. PER HP. | LBS. PER HR. | PER B.H.P. | | | | |
| 1 | 344 | 47.5 | 1.08 | 2.5 | 6.2 | 227 | 113 | 120 | 16 | 3/32 | 8000 | 56000 | 9.72 | 2.43 | 5.6 | 30.2 | 64.2 | 40 |
| 2 | 826 | 45.5 | 9.39 | 9.0 | 18.4 | 217 | 101 | 106 | 16 | 1/8 | 13350 | 66750 | 11.78 | 12.5 | 10.7 | 29.8 | 59.6 | 40 |
| 3 | 1033 | 38.5 | 10.13 | 13.5 | 23.6 | 184 | 114 | 119 | 16 | 1/8 | 16000 | 90000 | 14.04 | 13.7 | 9.7 | 33.7 | 56.6 | 40 |
| 4 | 1219 | 32.5 | 9.9 | 17.0 | 26.9 | 15.5 | 116 | 122 | 16 | 3/16 | 18000 | 108000 | 15.84 | 16.0 | 8.4 | 35.8 | 55.8 | 40 |
| 5 | 1514 | 19.3 | 7.3 | 24.0 | 31.3 | 9.2 | 114 | 120 | 16 | 1/2 | 21200 | 127200 | 20.66 | 2.83 | 4.7 | 32.4 | 52.8 | 40 |
| 6 | 1666 | 10.5 | 4.37 | 27.5 | 31.87 | 5.02 | 115 | 121 | 16 | 9/16 | 21900 | 131400 | 20.16 | 4.38 | 2.9 | 34.2 | 62.9 | 40 |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
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PACKARD MOTOR TEST

OBJECT: FRICTION H.P. **DATE 4-14-15**

SUCTION-WIDE OPEN THROTTLE **TEMP 65 °F**

TEST NO. 8 **BAR. 29.4 HG**

| RUN NO. | R.P.M. | TORQUE | F.H.P. | SUCTION INTAKE IN. HG. | TEMP COOLING WATER DEG. F | |
|---------|--------|--------|--------|------------------------|---------------------------|--------|
| | | | | | INLET | OUTLET |
| 1 | 263 | 13.5 | .888 | $\frac{3}{16}$ | 123 | 125 |
| 2 | 351 | 14.8 | 1.30 | $\frac{1}{4}$ | 123 | 124 |
| 3 | 470 | 17.5 | 2.06 | $\frac{3}{8}$ | 118 | 119 |
| 4 | 570 | 21.0 | 2.99 | $\frac{3}{8}$ | 116 | 117 |
| 5 | 694 | 25.25 | 4.38 | $\frac{7}{16}$ | 116 | 117 |
| 6 | 810 | 29.3 | 5.93 | $\frac{1}{2}$ | 116 | 117 |
| 7 | 974 | 36.0 | 8.76 | $\frac{5}{8}$ | 116 | 117 |
| | | | | | | |
| | | | | | | |

PACKARD MOTOR TEST

OBJECT: FRICTION H.P.

DATE 4-14-15

SUCTION-

TEMP. 65°F

TEST NO. 9

BAR. 29.4 HG.

| RUN NO. | R.P.M. | TORQUE | F.H.P. | SUCTION INTAKE IN. HG. | TEMP. COOLING WATER DEG. F. | |
|---------|--------|--------|--------|------------------------|-----------------------------|--------|
| | | | | | INLET | OUTLET |
| 1 | 260 | 16.5 | 1.07 | 2 | 115 | 116 |
| 2 | 386 | 18.0 | 1.66 | 2 | 114 | 115 |
| 3 | 449 | 19.5 | 2.19 | 2 | 114 | 115 |
| 4 | 565 | 22.5 | 3.18 | 2 | 114 | 115 |
| 5 | 663 | 25.3 | 4.18 | 2 | 113 | 114 |
| 6 | 773 | 28.5 | 5.51 | 2 | 113 | 114 |
| 7 | 912 | 34.0 | 7.75 | 2 | 113 | 115 |
| 8 | 980 | 37.0 | 9.06 | 2 | 114 | 115 |
| 9 | 1008 | 38.0 | 9.43 | 2 | 115 | 117 |

PACKARD MOTOR TEST

OBJECT: FRICTION H.P.

DATE: 4-14-15

SUCTION - 3"

TEMP. 65 °F

TEST NO. 10

BAR. 29.4" Hg

| RUN NO. | R.P.M. | TORQUE | F.H.P. | SUCTION INTAKE | TEMP. COOLING WATER DEG. F. | |
|---------|--------|--------|--------|----------------|-----------------------------|--------|
| | | | | | INLET | OUTLET |
| 1 | 268 | 17.25 | 1.16 | 3 | 115 | 116 |
| 2 | 364 | 18.25 | 1.66 | 3 | 114 | 115 |
| 3 | 464 | 20.25 | 2.35 | 3 | 114 | 115 |
| 4 | 570 | 23.5 | 3.35 | 3 | 113 | 114 |
| 5 | 700 | 27.5 | 4.82 | 3 | 113 | 114 |
| 6 | 826 | 31.5 | 6.51 | 3 | 114 | 115 |
| 7 | 886 | 34.5 | 7.64 | 3 | 114 | 115 |
| 8 | 988 | 37.75 | 9.33 | 3 | 114 | 115 |
| | | | | | | |

PACKARD MOTOR TEST

OBJECT: FRICTION H.P.

DATE 4-14-15

SUCTION - 6"

TEMP. 65 °F

TEST NO. 11

BAR. 29.4" HG.

| RUN NO. | R.P.M. | TORQUE | F.H.P. | SUCTION INTAKE IN. HG. | TEMP. COOLING WATER DEG. F. | |
|---------|--------|--------|--------|------------------------|-----------------------------|--------|
| | | | | | INLET | OUTLET |
| 1 | 306 | 18.5 | 1.42 | 6 | 115 | 116 |
| 2 | 376 | 20.25 | 1.9 | 6 | 115 | 116 |
| 3 | 504 | 23.25 | 2.17 | 6 | 114 | 115 |
| 4 | 618 | 26.5 | 4.1 | 6 | 114 | 115 |
| 5 | 726 | 30.0 | 5.44 | 6 | 114 | 115 |
| 6 | 854 | 33.75 | 7.2 | 6 | 114 | 115 |
| 7 | 930 | 38.75 | 9.01 | 6 | 114 | 115 |
| | | | | | | |
| | | | | | | |

PAGKARD MOTOR TEST

OBJECT: FRICTION H.P.

DATE 4-14-15

SUCTION - 10"

TEMP. 65°F.

TEST NO. 12

BAR. 29.4" Hg.

| RUN NO. | R.P.M. | TORQUE | F.H.P. | SUCTION INTAKE IN. Hg. | TEMP. COOLING WATER DEG. F. | |
|------------|--------|--------|--------|------------------------------|-----------------------------------|--------|
| | | | | | INLET | OUTLET |
| 1 | 252 | 20.25 | 1.28 | 10 | 115 | 116 |
| 2 | 350 | 23.5 | 2.06 | 10 | 115 | 116 |
| 3 | 444 | 26.0 | 2.89 | 10 | 114 | 115 |
| 4 | 596 | 29.5 | 4.4 | 10 | 114 | 115 |
| 5 | 710 | 33.0 | 5.86 | 10 | 114 | 115 |
| 6 | 820 | 36.25 | 7.43 | 10 | 114 | 115 |
| 7 | 958 | 44.75 | 10.0 | 10 | 114 | 115 |
| | | | | | | |
| | | | | | | |

PACKARD MOTOR TEST

OBJECT: FRICTION H.P.

DATE 4-14-15

SUCTION-14"

TEMP. 65°F.

TEST NO. 13

BAR. 29.4" HG.

| RUN NO. | R.P.M. | TORQUE | F.H.P. | SUCTION INTAKE IN. HG. | TEMP. COOLING WATER DEG. F. | |
|---------|--------|--------|--------|------------------------|-----------------------------|--------|
| | | | | | INLET | OUTLET |
| 1 | 268 | 23.0 | 1.54 | 14 | 114 | 115 |
| 2 | 354 | 25.6 | 2.27 | 14 | 114 | 115 |
| 3 | 460 | 29.0 | 3.34 | 14 | 113 | 114 |
| 4 | 586 | 32.5 | 4.76 | 14 | 107 | 108 |
| 5 | 734 | 36.75 | 6.75 | 14 | 108 | 109 |
| 6 | 830 | 40.5 | 8.41 | 14 | 108 | 109 |
| | | | | | | |
| | | | | | | |
| | | | | | | |

PACKARD MOTOR TEST

OBJECT: FRICTION H.P.

DATE 4-14-15

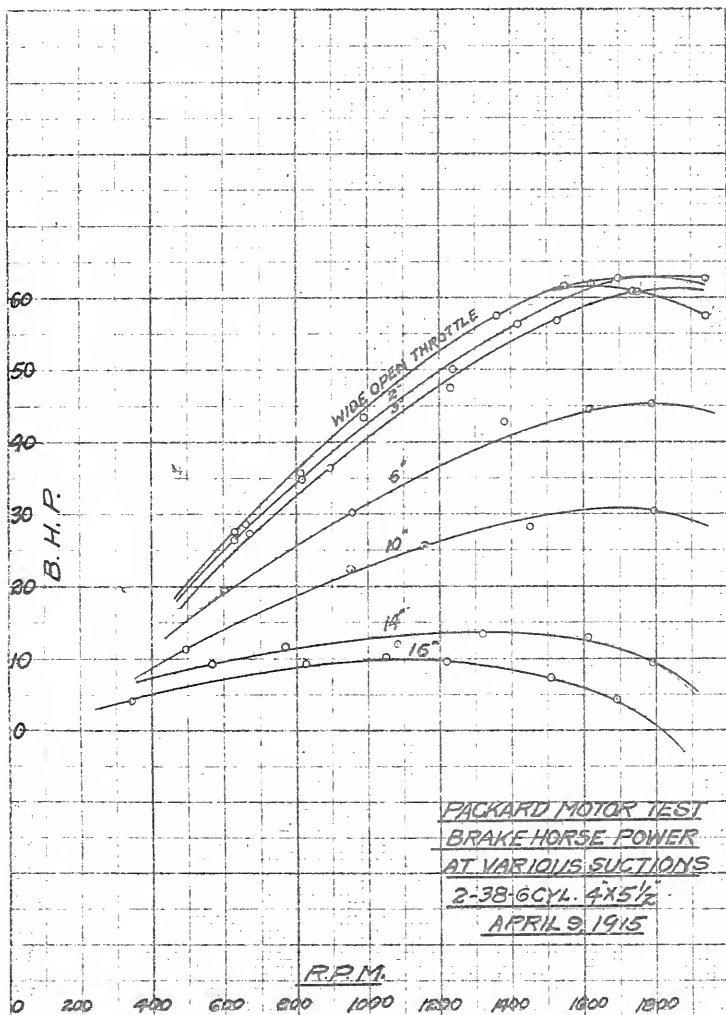
SUCTION 16"

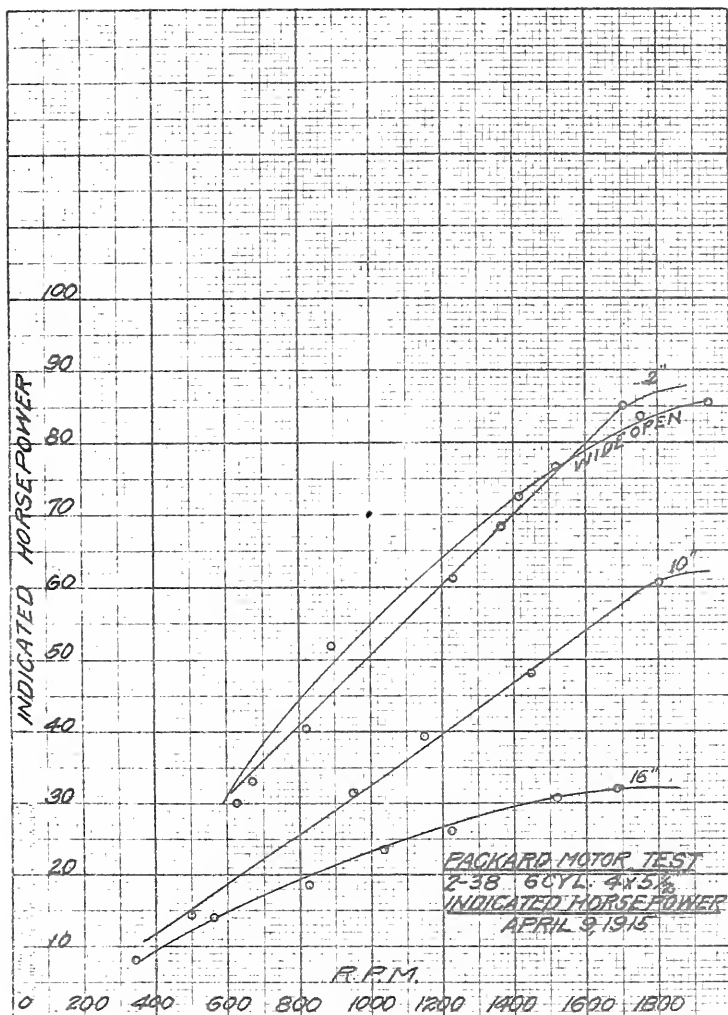
TEMP. 65°F

TEST NO. 14

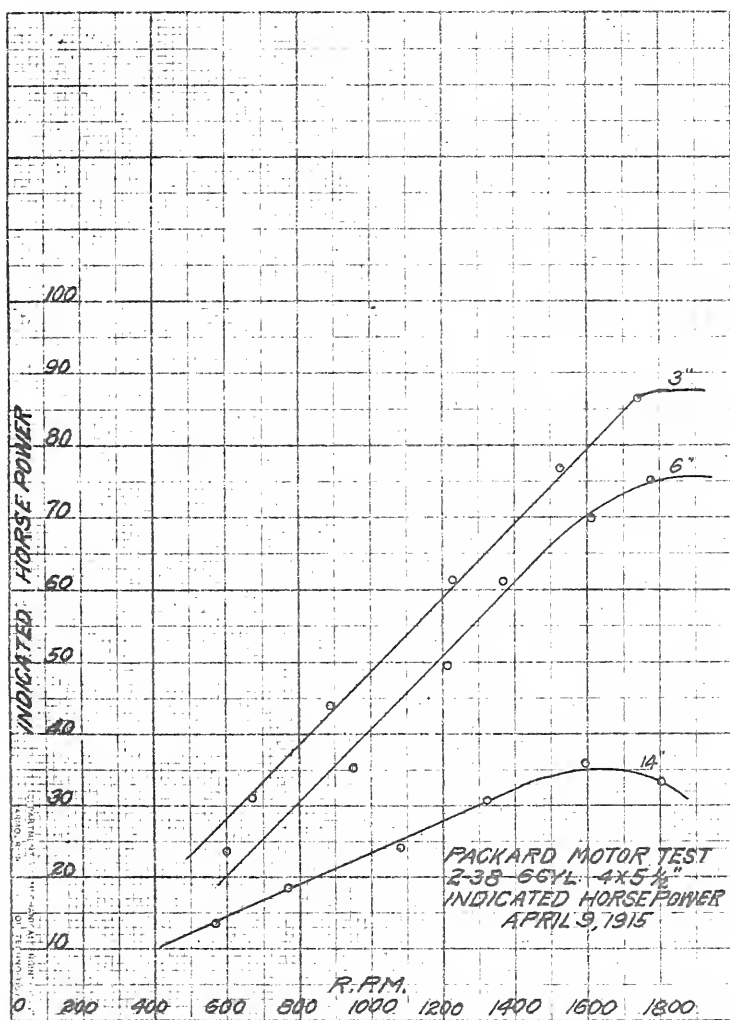
BAR. 29.4 HG.

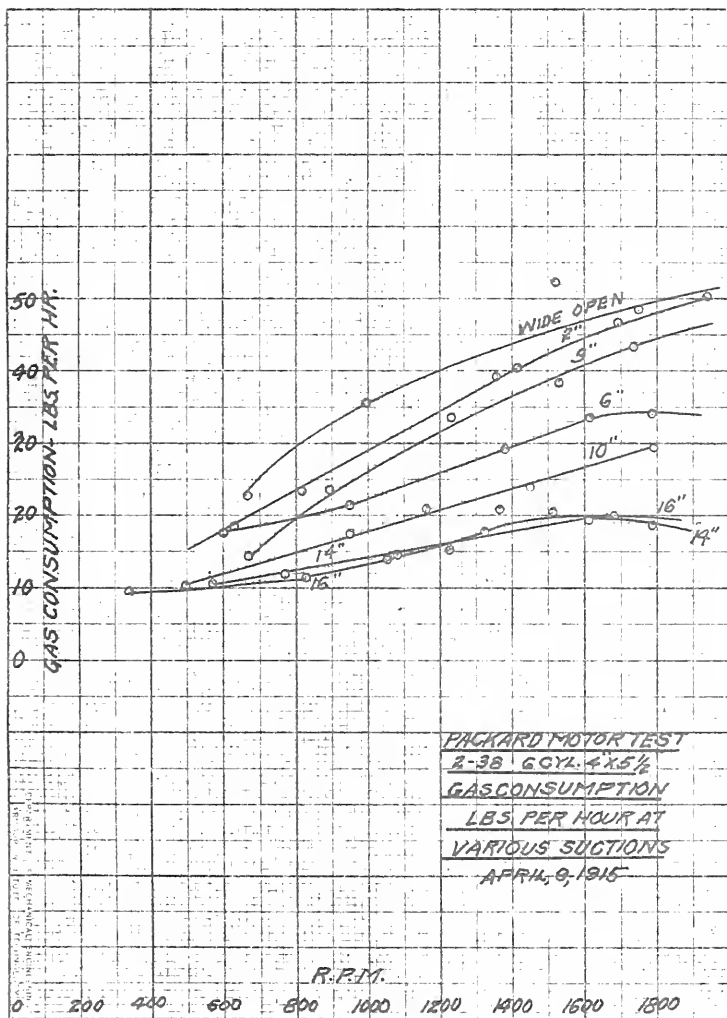
| RUN NO. | R.P.M. | TORQUE | F.H.P. | SUCTION INTAKE IN. HG. | TEMP. COOLING WATER DEG. F. | |
|---------|--------|--------|--------|------------------------|-----------------------------|--------|
| | | | | | INLET | OUTLET |
| 1 | 222 | 24.0 | 1.33 | 16 | 107 | 108 |
| 2 | 340 | 28.25 | 2.4 | 16 | 108 | 109 |
| 3 | 476 | 31.75 | 3.77 | 16 | 108 | 109 |
| 4 | 616 | 37.75 | 5.81 | 16 | 108 | 109 |
| 5 | 744 | 41.5 | 7.76 | 16 | 108 | 109 |
| 6 | 854 | 44.5 | 9.5 | 16 | 108 | 109 |
| | | | | | | |
| | | | | | | |
| | | | | | | |

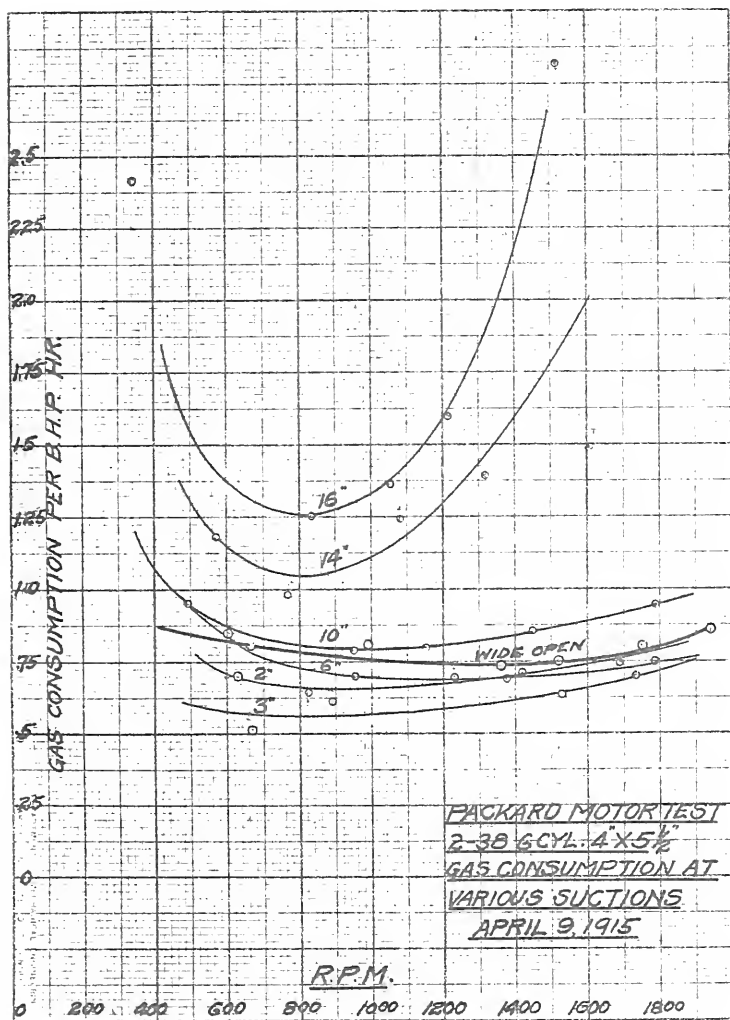


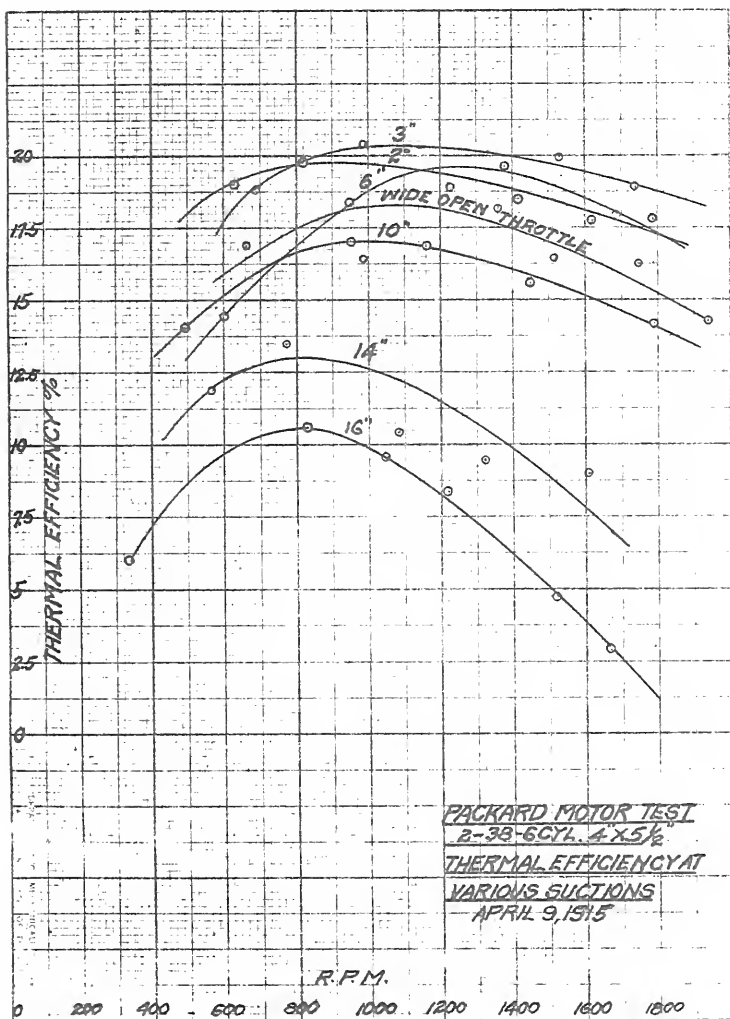


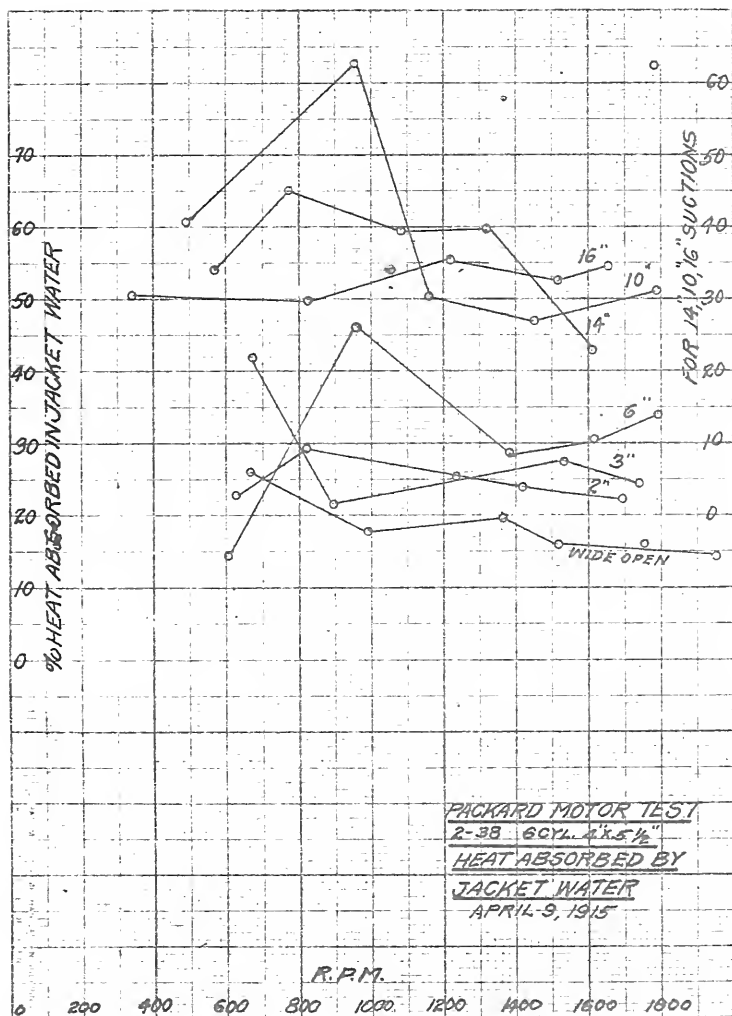


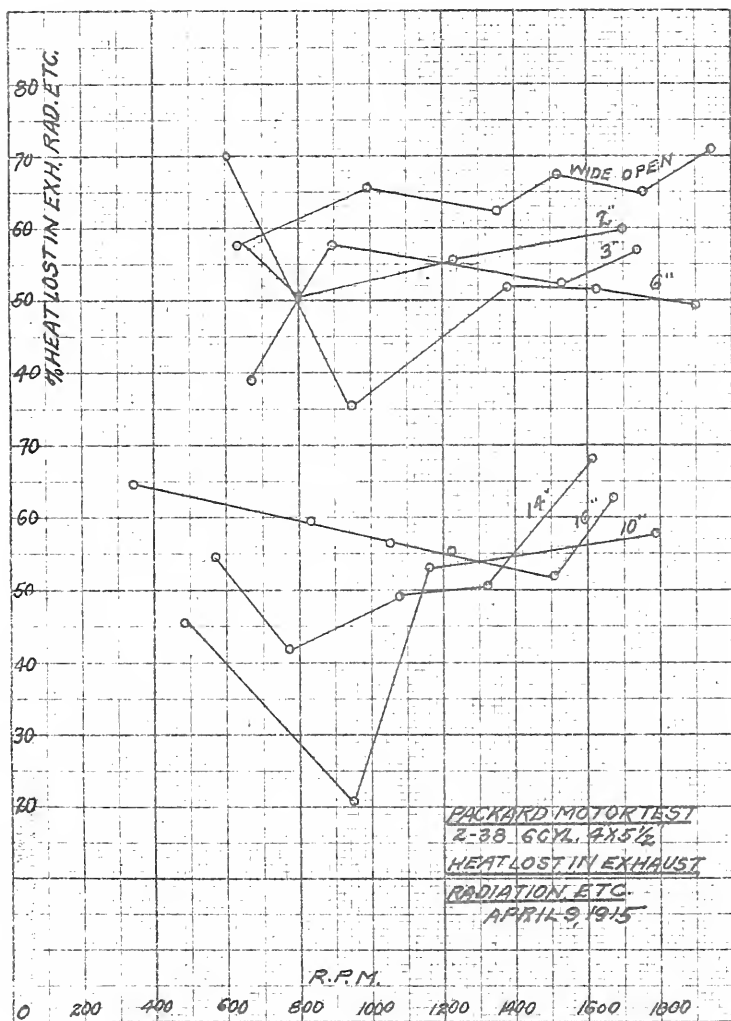


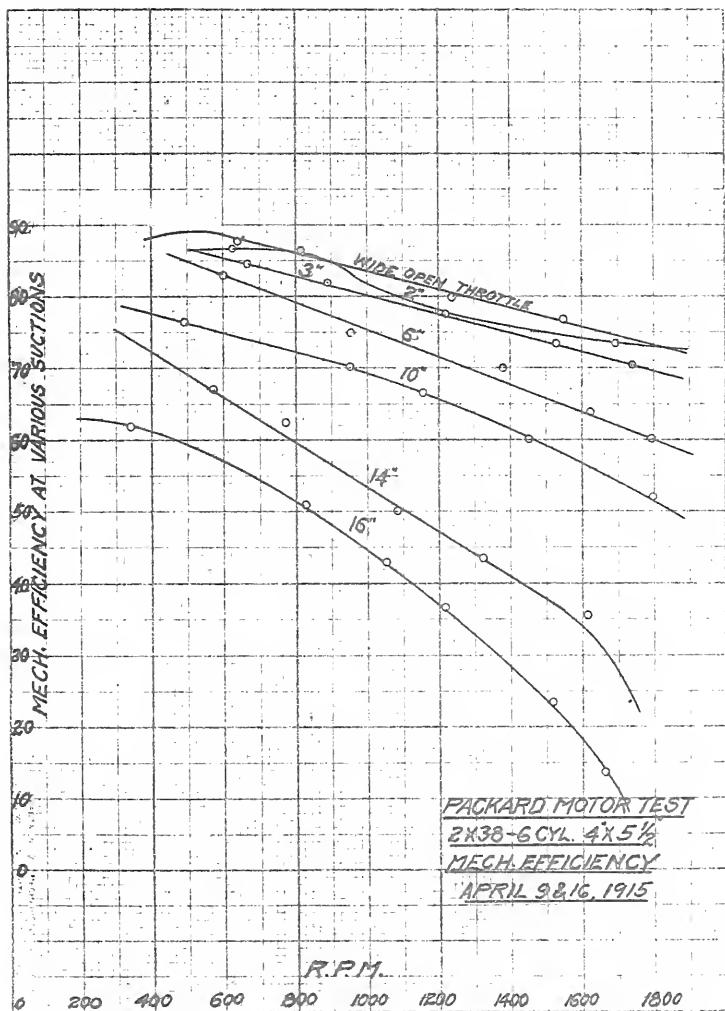


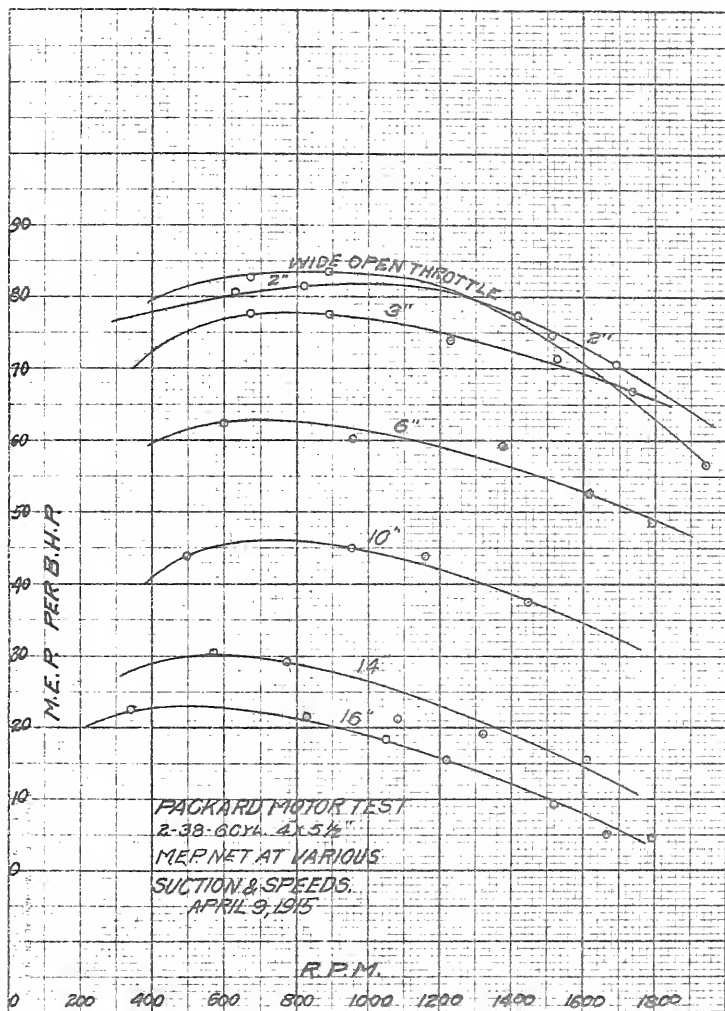


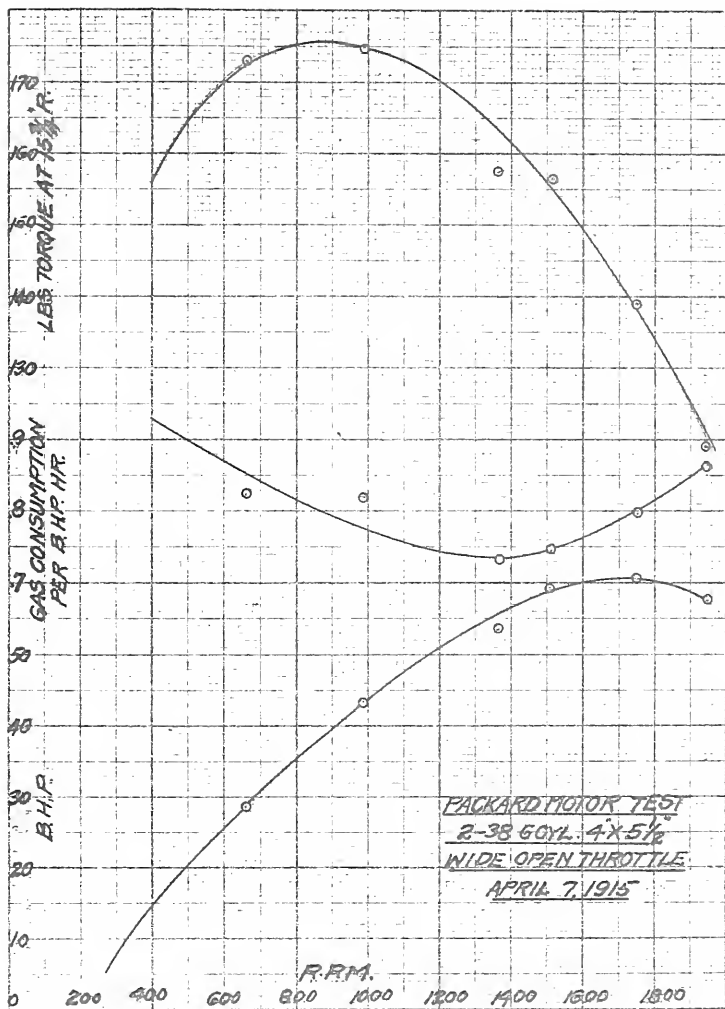


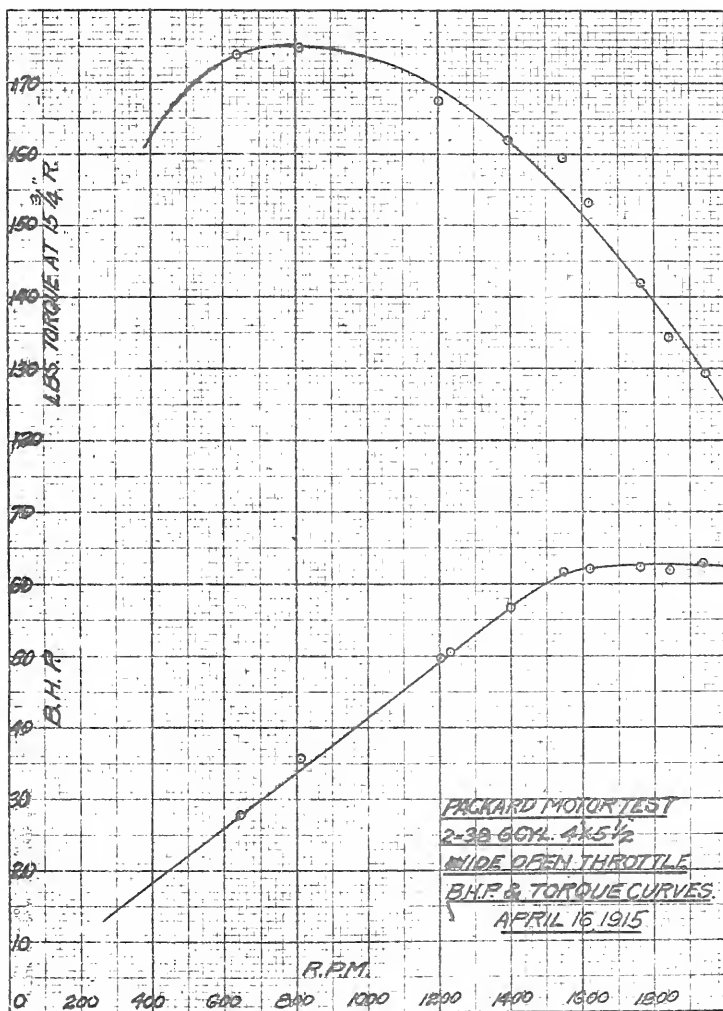


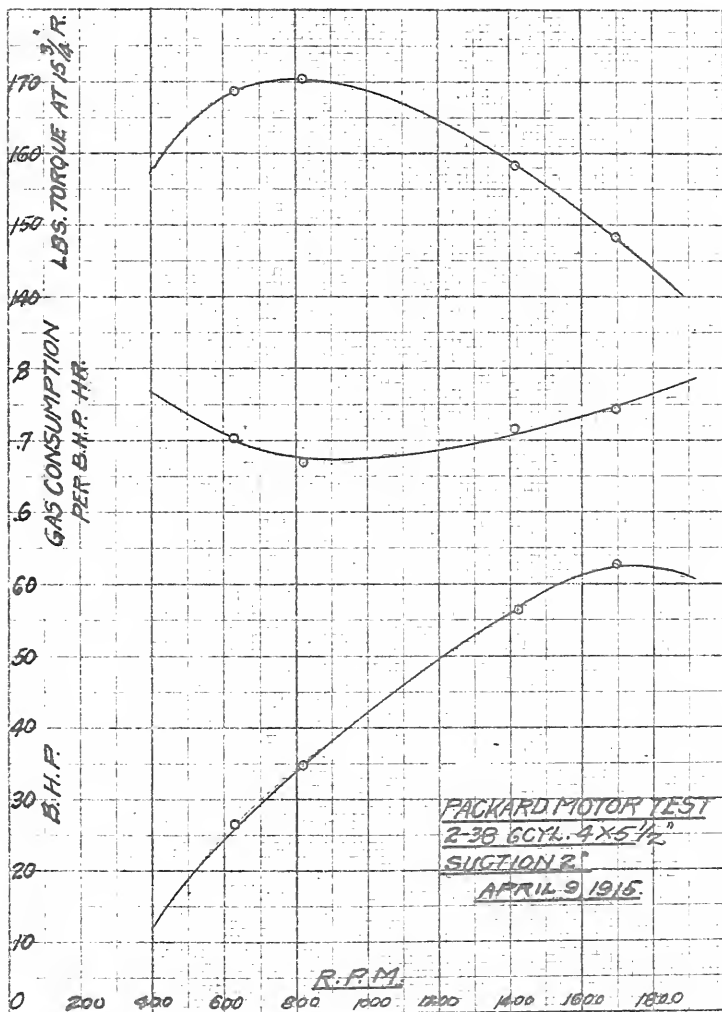


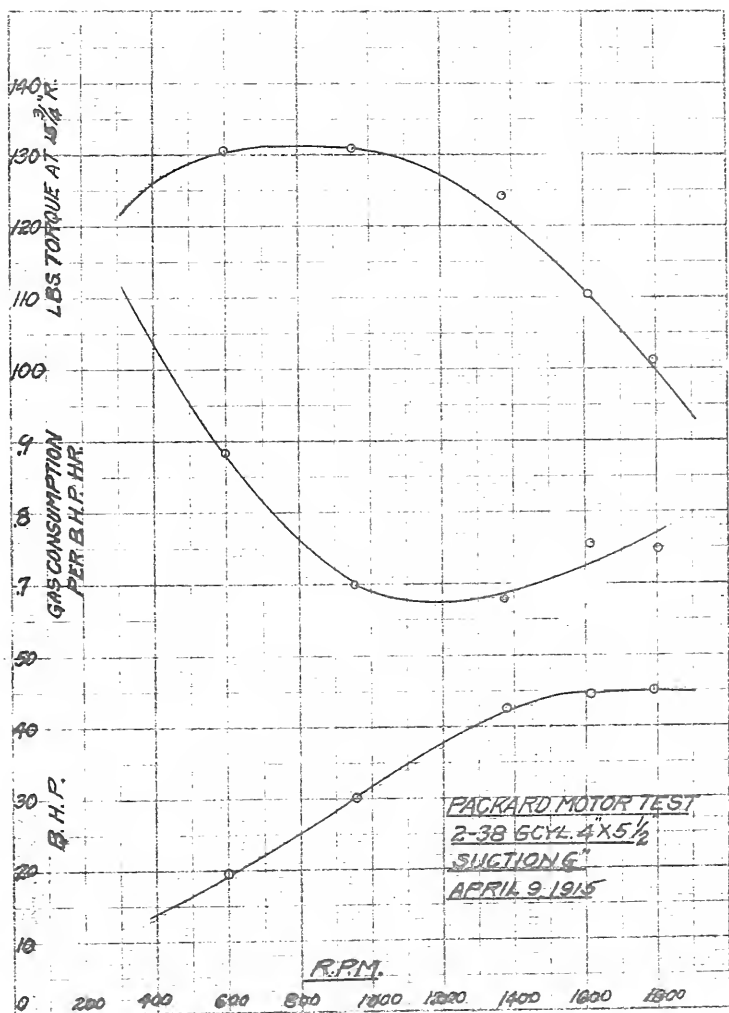


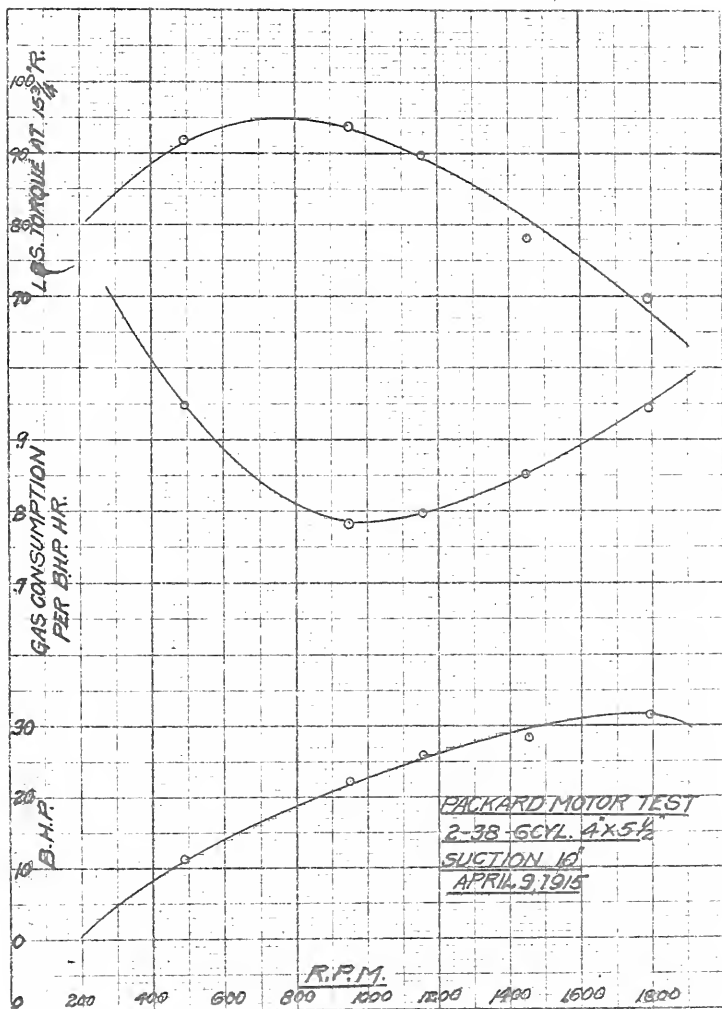


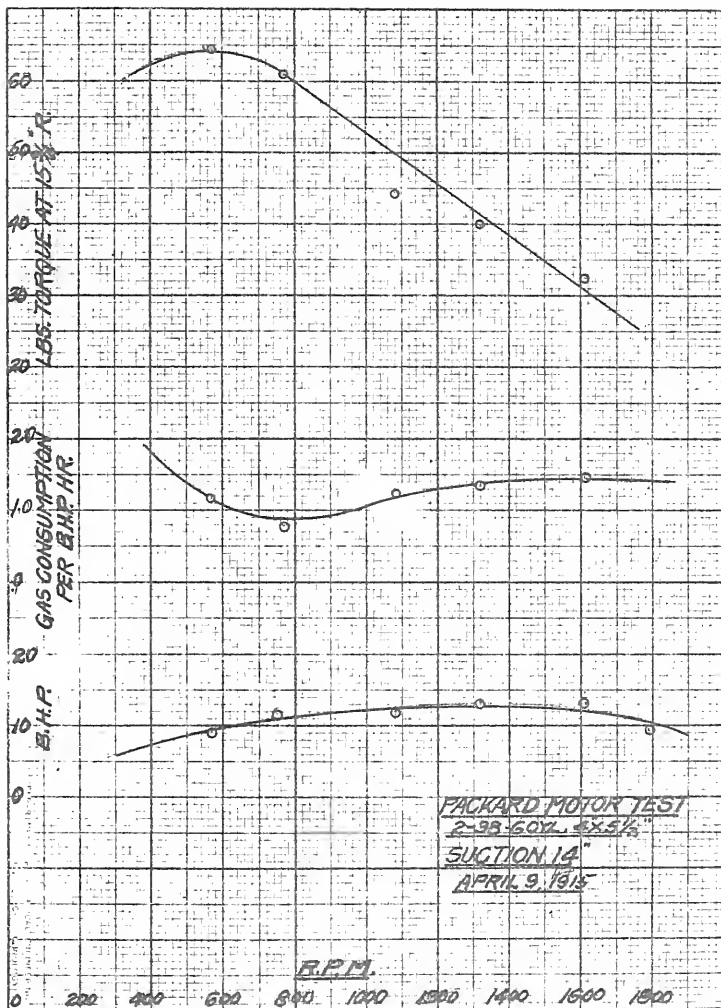


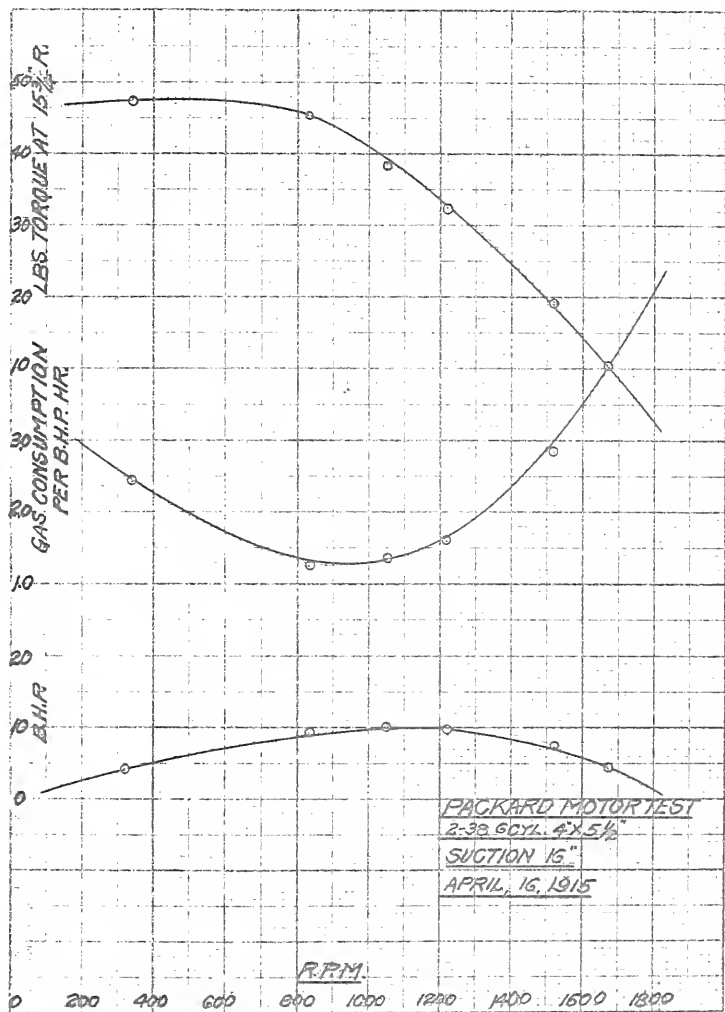


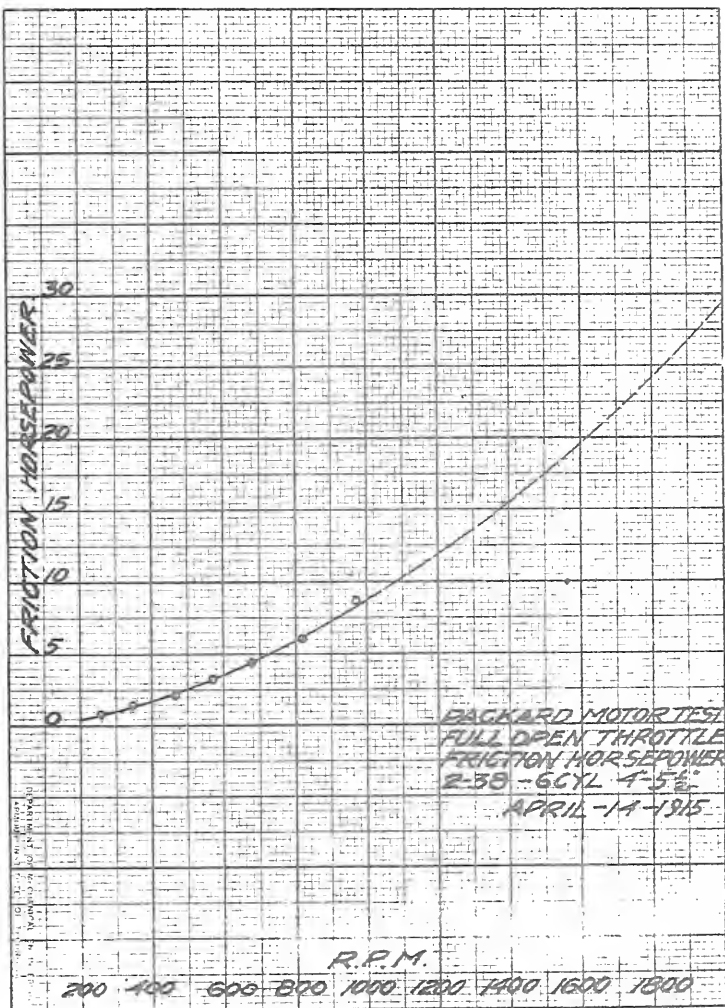


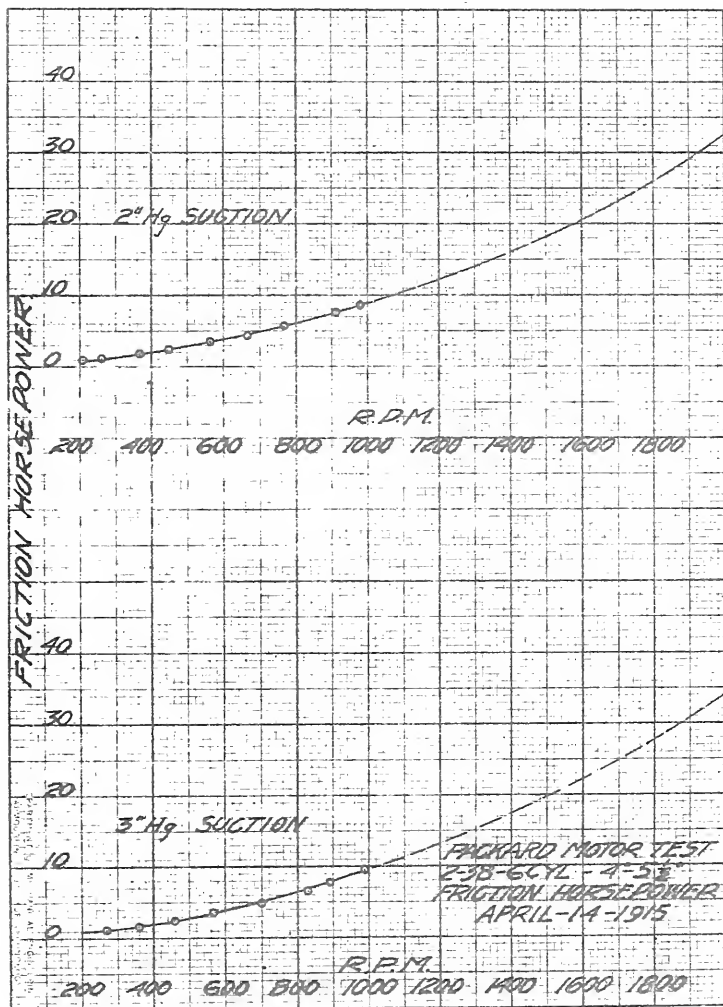


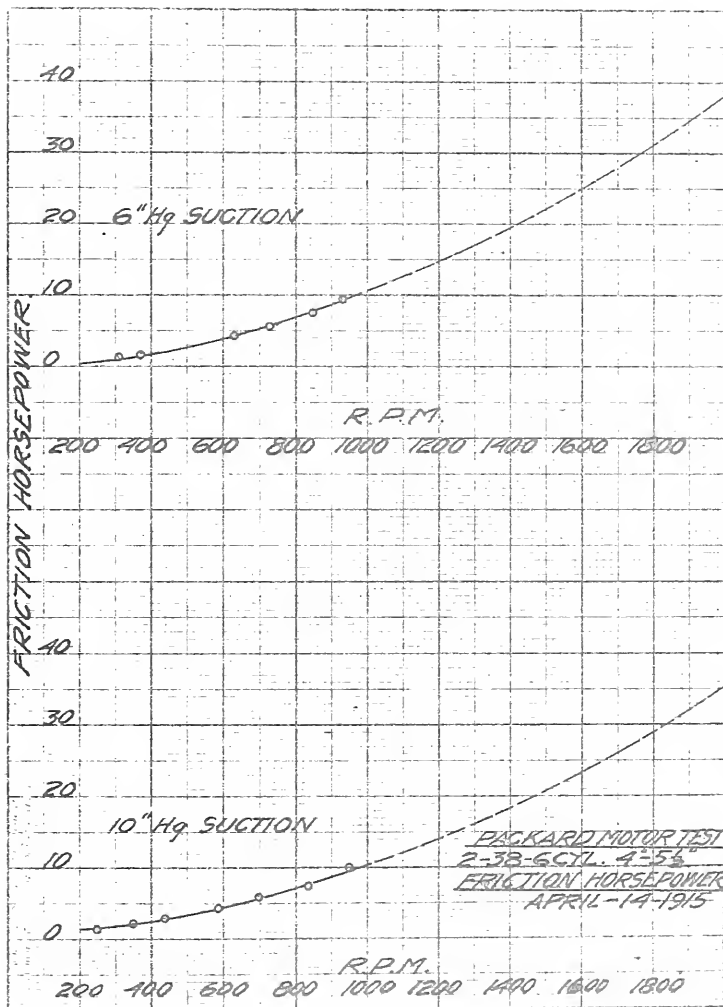


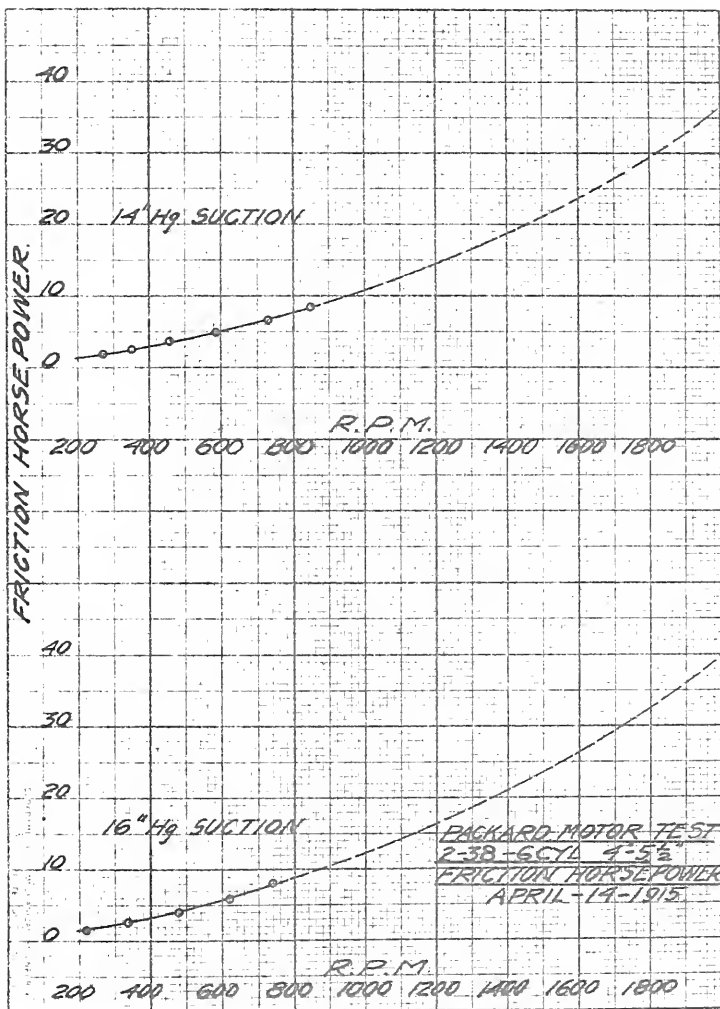












Monograph Cards
for
Different Speeds, Loads, and
Suction Pressures.

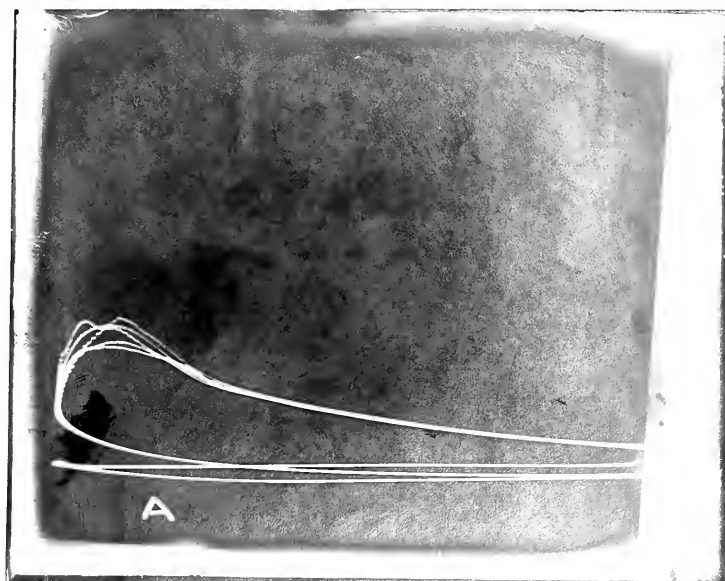
Suction 16 inches.

R. P. M. 666

Torque 44.7

Spark 40

B. H. P. 7.45



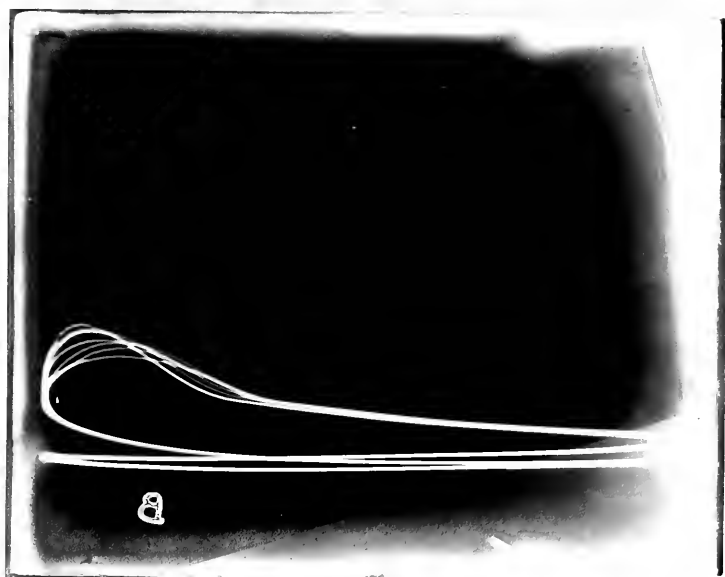
| | |
|---------|------------|
| Suction | 16 inches. |
|---------|------------|

| | |
|----------|-----|
| R. P. M. | 890 |
|----------|-----|

| | |
|--------|------|
| Torque | 31.0 |
|--------|------|

| | |
|-------|----|
| Spark | 40 |
|-------|----|

| | |
|----------|-----|
| B. H. P. | 6.9 |
|----------|-----|



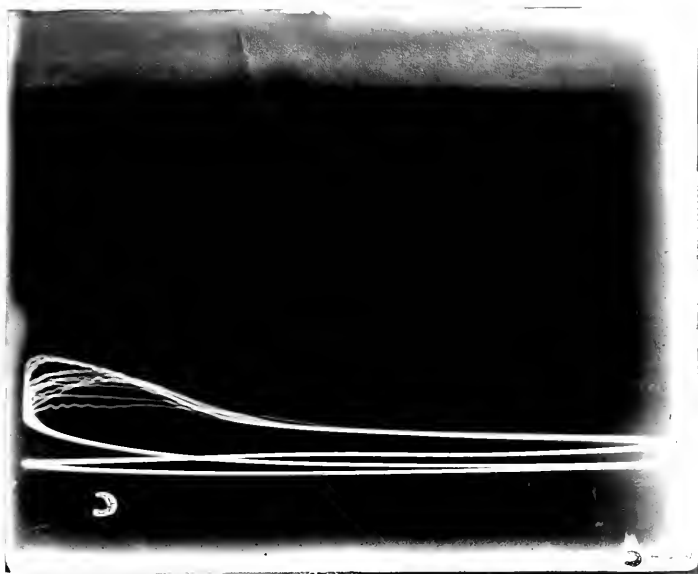
Suction 16 inches

R. P. M. 16.8

Torque 12

Spark 40

B. H. P. 4.85



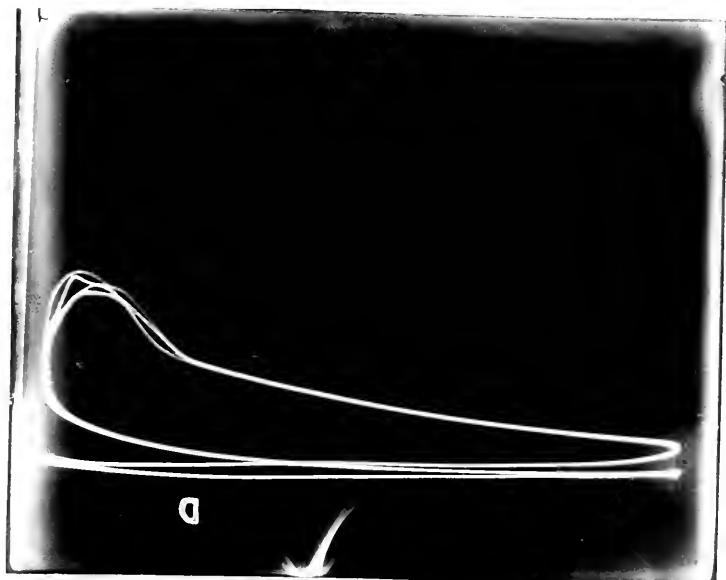
Suction 14 inches.

R. P. M. 670

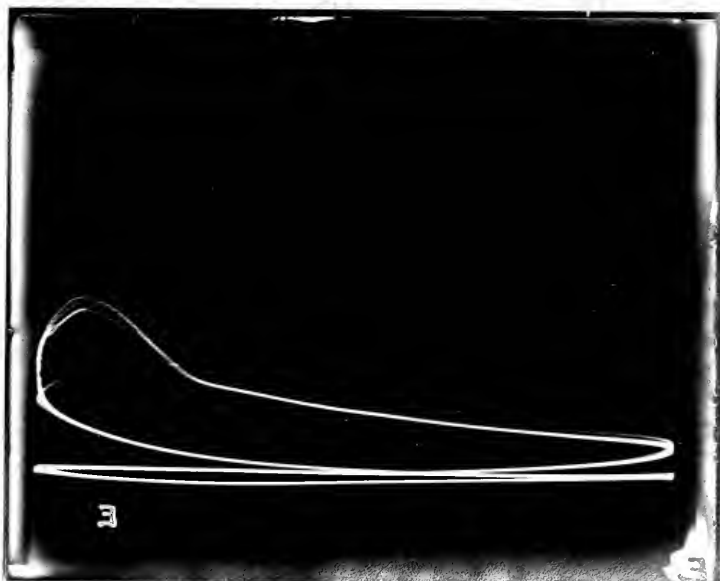
Torque 63

Spark 40

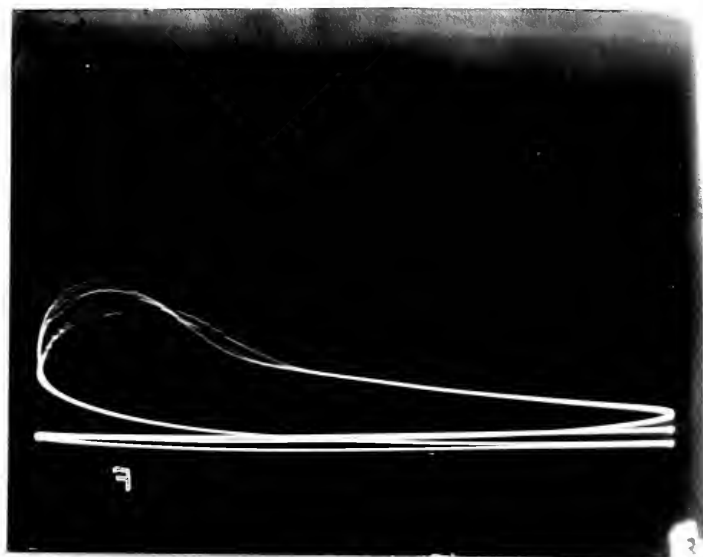
B. H. P. 10.55



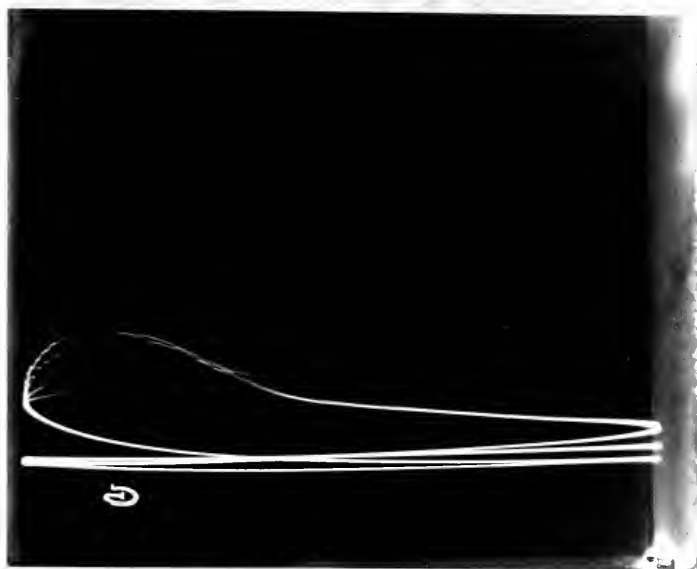
| | |
|----------|-----------|
| Suction | 14 inches |
| R. P. M. | 884 |
| Torque | 63.5 |
| Spark | 40 |
| B. H. P. | 14.0 |



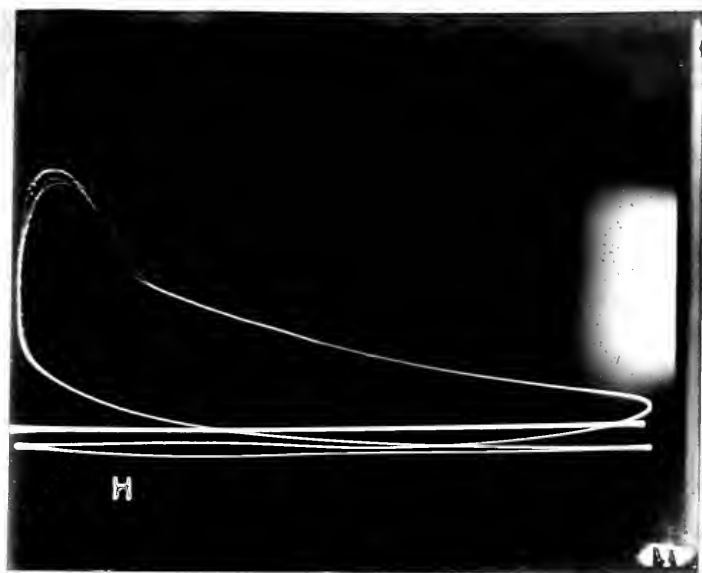
| | |
|----------|-----------|
| Suction | 14 inches |
| R. P. M. | 1098 |
| Torque | 54.0 |
| Spark | 40 |
| B. H. P. | 14.85 |



| | |
|----------|-----------|
| Suction | 14 inches |
| R. P. M. | 1522 |
| Torque | 45 |
| Spark | 40 |
| B. H. P. | 16.75 |



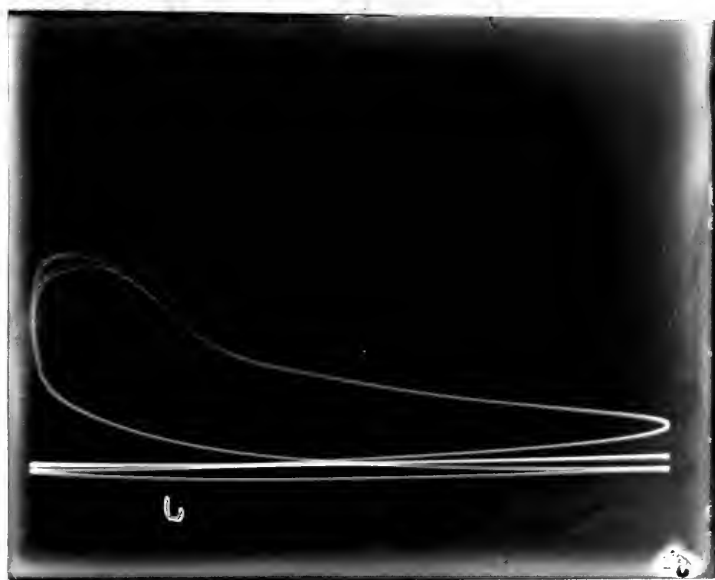
| | |
|----------|-----------|
| Suction | 10 inches |
| R. P. M. | 724 |
| Torque | 100 |
| Spark | 40 |
| B. H. P. | 18.1 |



| | |
|----------|-----------|
| Suction | 10 inches |
| R. P. M. | 1000 |
| Torque | 99 |
| Spark | 40 |
| B. H. P. | 24.8 |

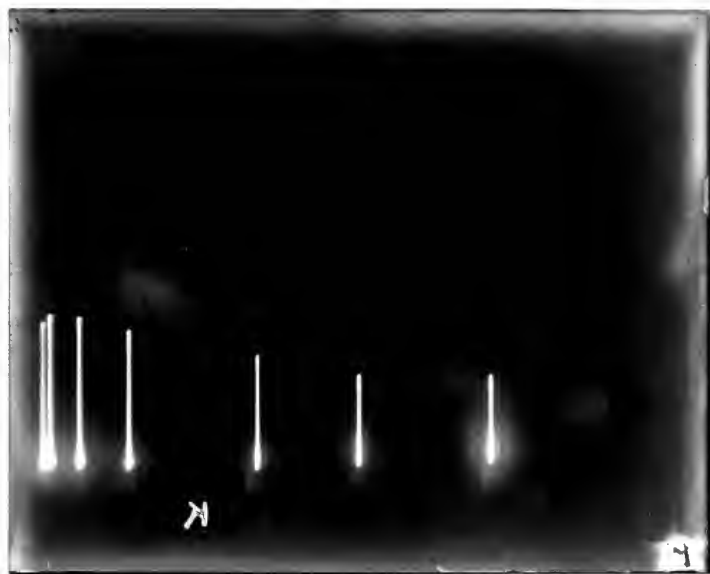


| | |
|----------|-----------|
| Suction | 10 inches |
| R. P. M. | 1650 |
| Torque | 31 |
| Spark | 40 |
| B. H. P. | 12.8 |

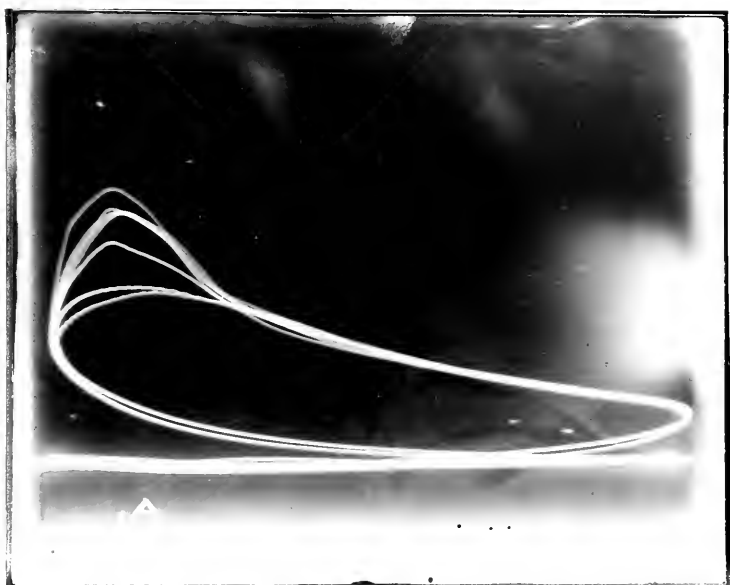


Compression Card.

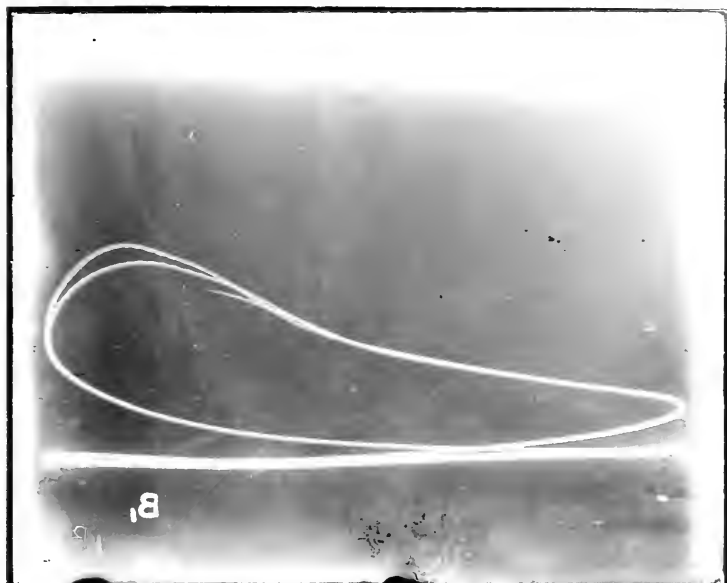
| R.P.M. | Suction. |
|--------|----------|
| 620 | $1/2$ |
| 850 | $7/8$ |
| 1025 | $1-1/8$ |
| 1225 | $1-3/8$ |
| 1475 | $1-5/8$ |
| 1925 | $2-1/8$ |
| 2000 | $2-1/4$ |



| | |
|----------|----------|
| Suction | 6 inches |
| R. P. M. | 682 |
| Torque | 126.5 |
| Spark | 34 |
| B. H. P. | 21.6 |



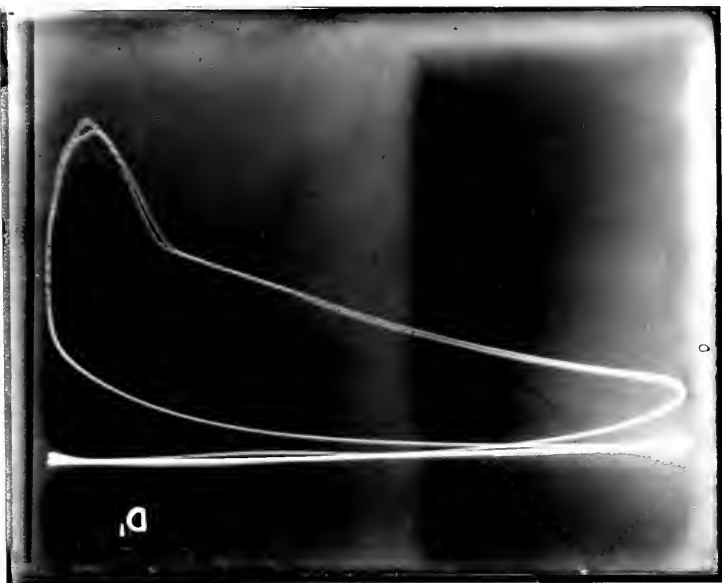
| | |
|----------|----------|
| Suction | 6 inches |
| R. P. M. | 1064 |
| Torque | 123.0 |
| Spark | 40 |
| B. H. P. | 32.8 |



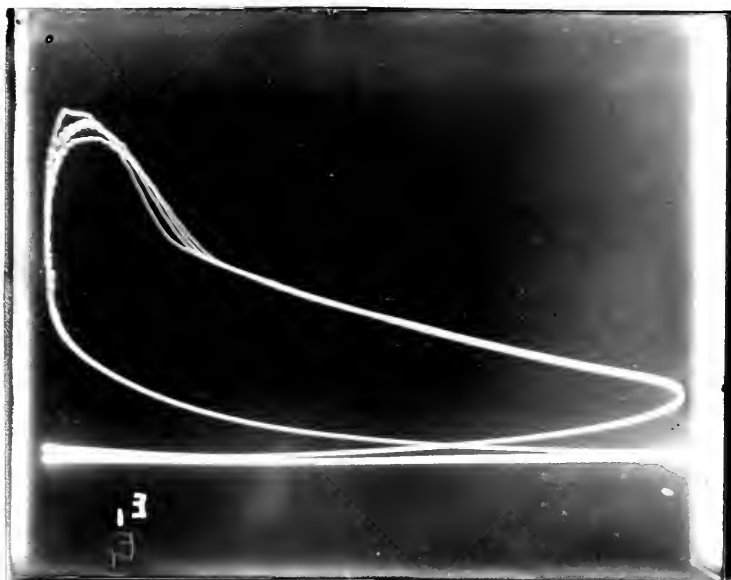
| | |
|----------|-----------|
| Suction | 6 inches. |
| R. P. M. | 1508 |
| Torque | 112 |
| Spark | 40 |
| B. H. P. | 42.3 |



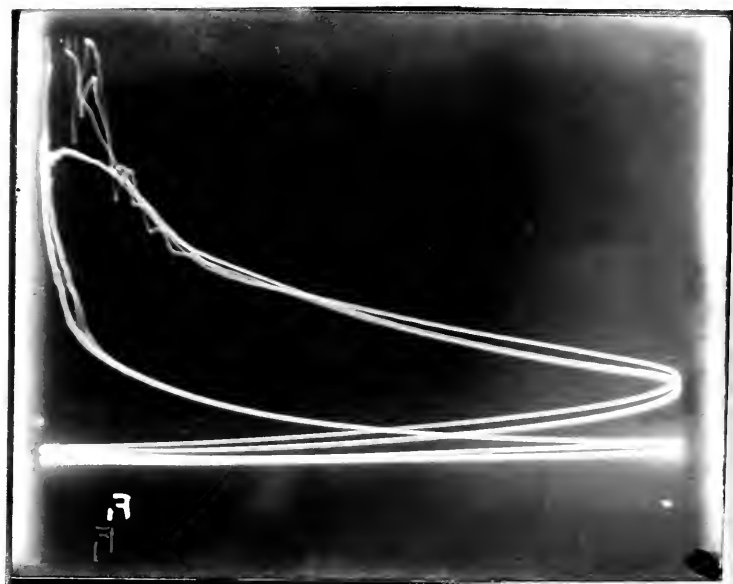
| | |
|----------|-----------|
| Suction | 3 inches. |
| R. P. M. | 692. |
| Torque | 158 |
| Spark | 32 |
| B. H. P. | 27.3 |



| | |
|----------|----------|
| Suction | 3 inches |
| R. P. M. | 1178. |
| Torque | 157 |
| Spark | 38 |
| B. H. P. | 46.1 |

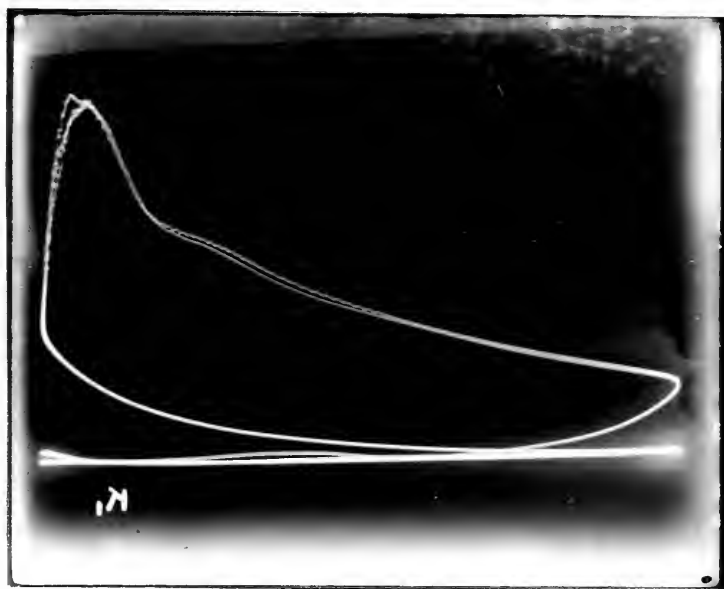


| | |
|----------|----------|
| Suction | 3 inches |
| R. P. M. | 1572 |
| Torque | 144.5 |
| Spark | 40 |
| B. H. P. | 56.8 |



Suction - Wide Open Throttle.

| | |
|----------|------|
| R. P. M. | 584 |
| Torque | 160 |
| Spark | 25 |
| B. H. P. | 23.4 |



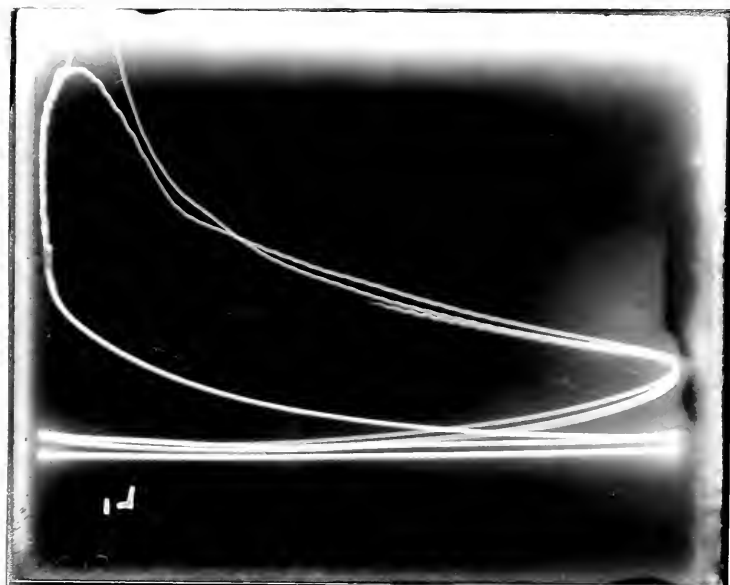
Suction - Wide Open Throttle.

| | |
|----------|------|
| R. P. M. | 584 |
| Torque | 160 |
| Spark | 25 |
| B. H. P. | 23.4 |



Suction - Wide Open Throttle

| | |
|----------|-------|
| R. P. M. | 1064. |
| Torque | 175. |
| Spark | 32 |
| B. H. P. | 46.5 |



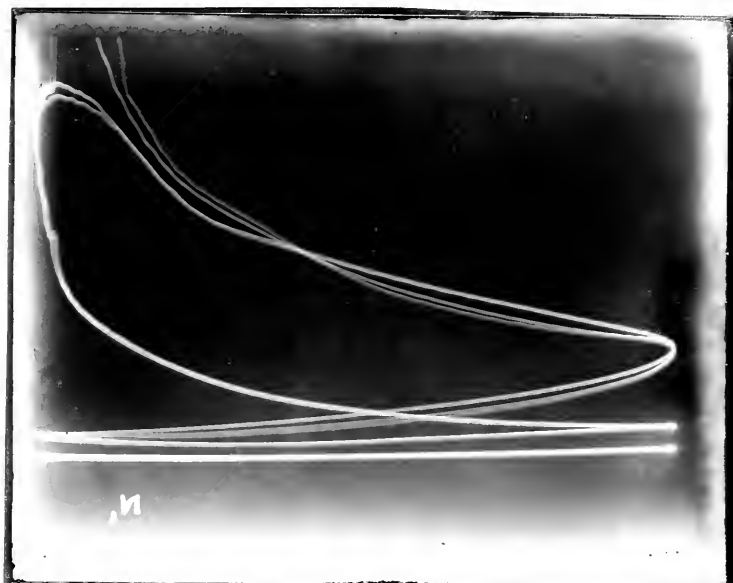
Suction 2 inches. Wide Open Throttle

R. P. M. 1534

Torque 157

Spark 40

B. H. P. 60.2



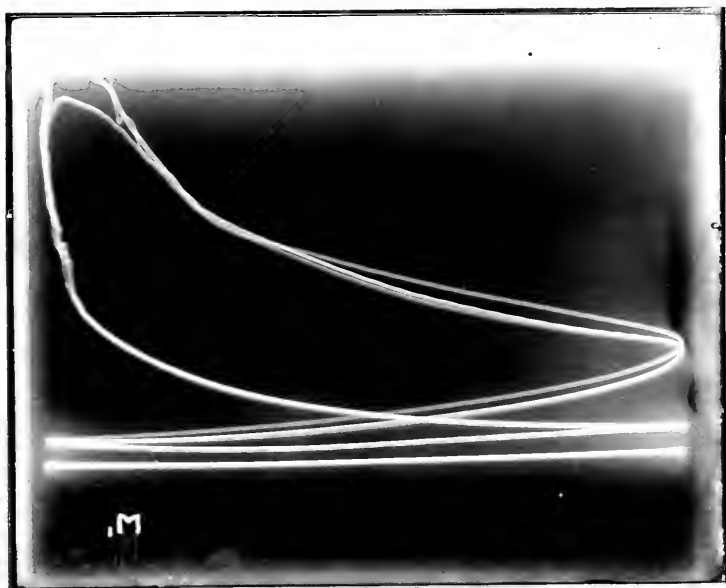
Suction 2 inches. Wide open Throttle.

R. P. M. 1534

Torque 157

Spark 40

B. H. P. 60.2

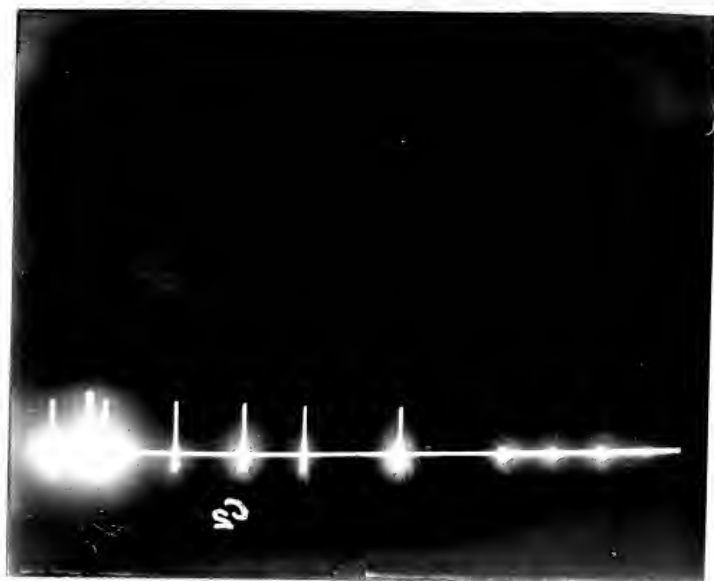


Compression Card

Suction 16 inches.

R. P. M.

540
690
860
1050
1175
1176

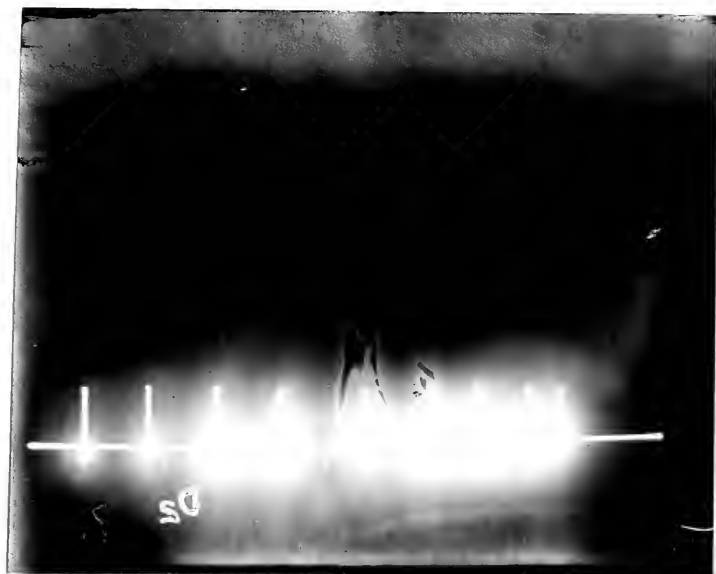


Compression Card

Suction 14 inches.

R. P. M.

490
650
850
1050
1225
1375
1550
1700
1840



Compression Card

Suction 10 inches

R. P. M.

555
650
820
975
1175
1350
1500
1650
1875



Compression Card

Suction 6 inches.

R. P. M.

560
740
925
1075
1250
1375
1500
1700
1800

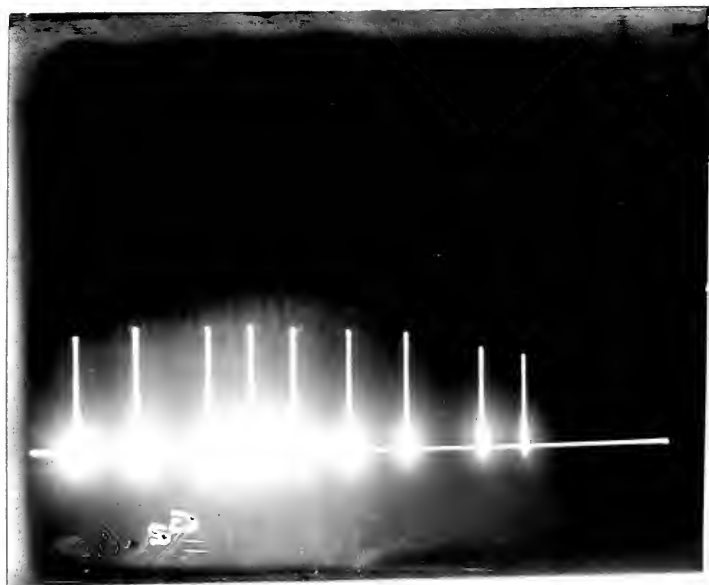


Compression Card.

Suction 3 inches.

R. P. M.

520
690
900
1050
1225
1375
1550
1750
1850

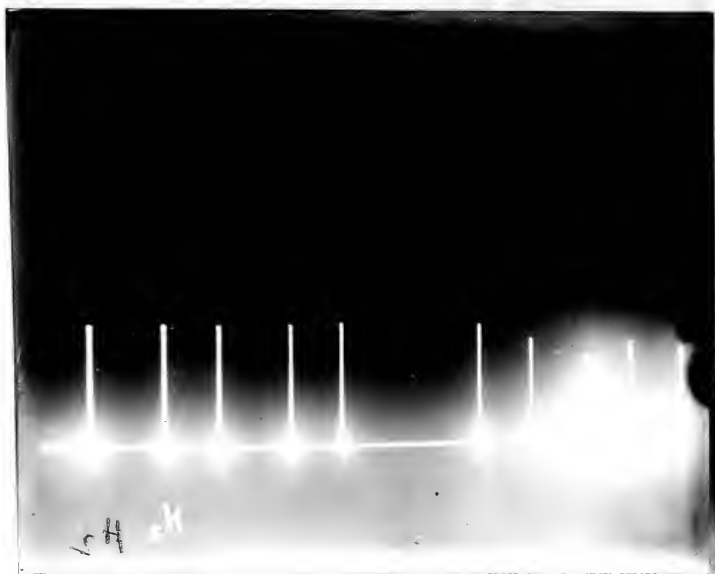


Compression Card

Suction 2 inches.

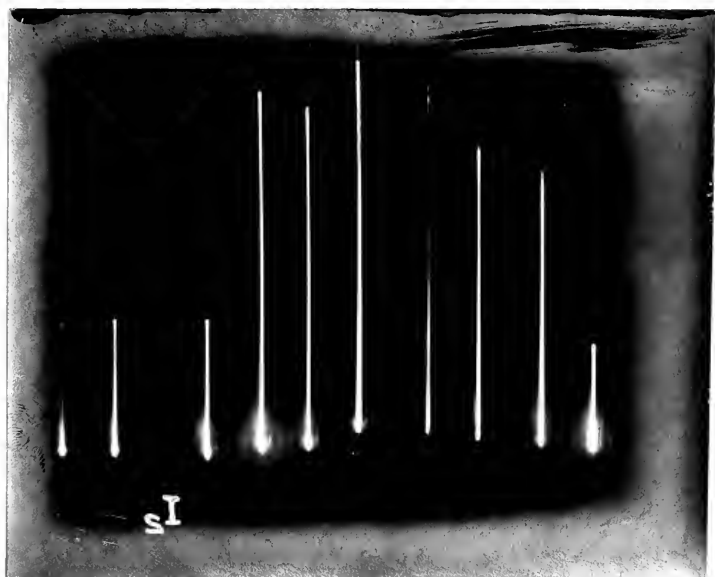
R. P. M.

515
700
850
1000
1125
1275
1450
1600
1700
1900



Compression Card

| R.P.M. | Wide Open Throttle. |
|--------|---------------------|
| | Suction |
| 500 | $\frac{3}{4}$ |
| 675 | $\frac{13}{16}$ |
| 960 | $1-\frac{1}{8}$ |
| 1075 | $1-\frac{3}{8}$ |
| 1300 | $1-\frac{3}{4}$ |
| 1500 | $2-\frac{1}{8}$ |
| 1700 | $2-\frac{3}{4}$ |
| 1900 | 3 |
| 1925 | $3-\frac{1}{8}$ |

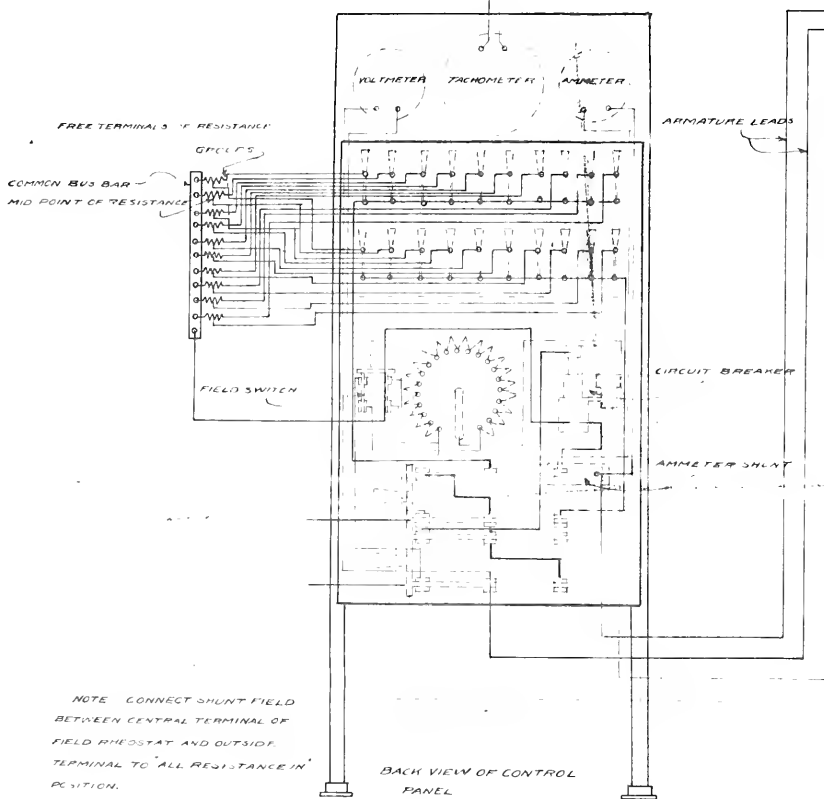


FR

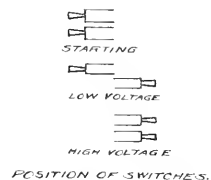
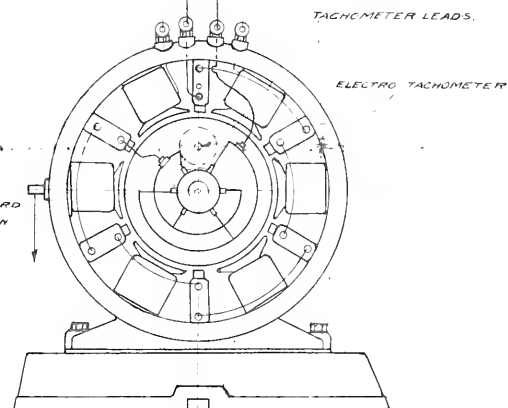
ION E

DOIN





PULL IS DOWNWARD ON THIS SIDE WHEN DRIVEN BY RIGHT HAND ENGINE



WIRING DIAGRAM FOR
100 HP. SPRAGUE ELECTRO-DYNAMOMETER.

AS INSTALLED AT ARMOUR INSTITUTE OF TECHNOLOGY
DRAWN BY: H. D. SUMPPER, MAY 28, 1914





